Recent EW results from LHCb

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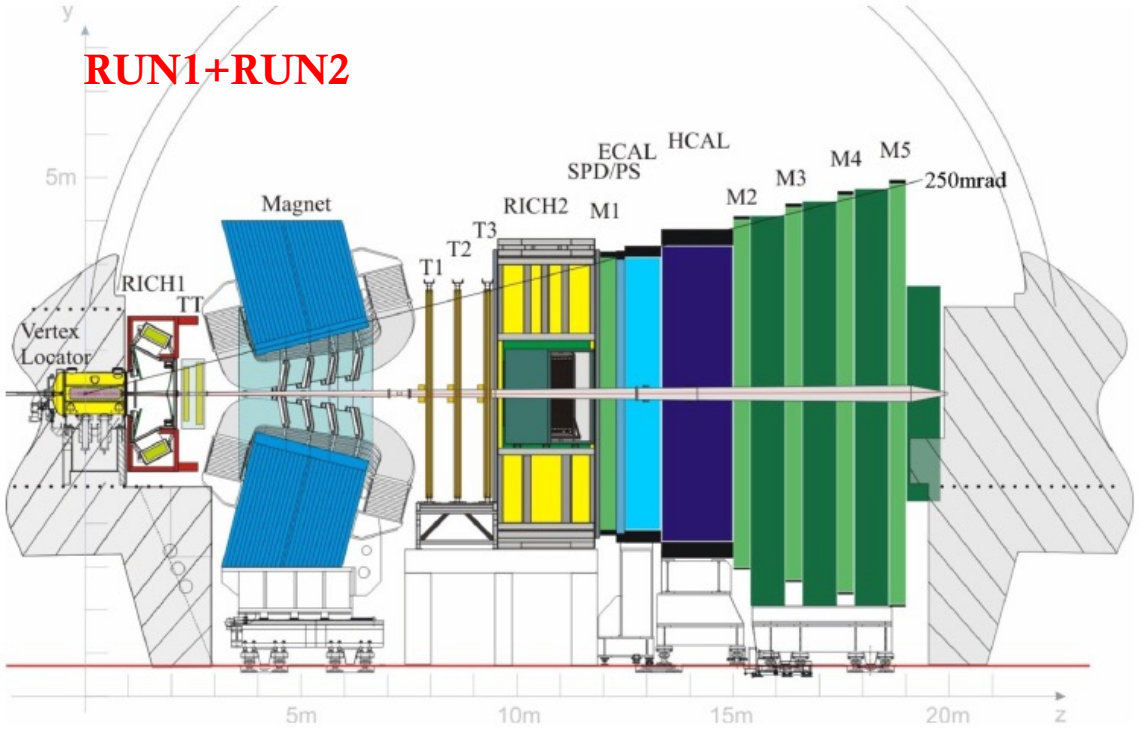
LHCb detector

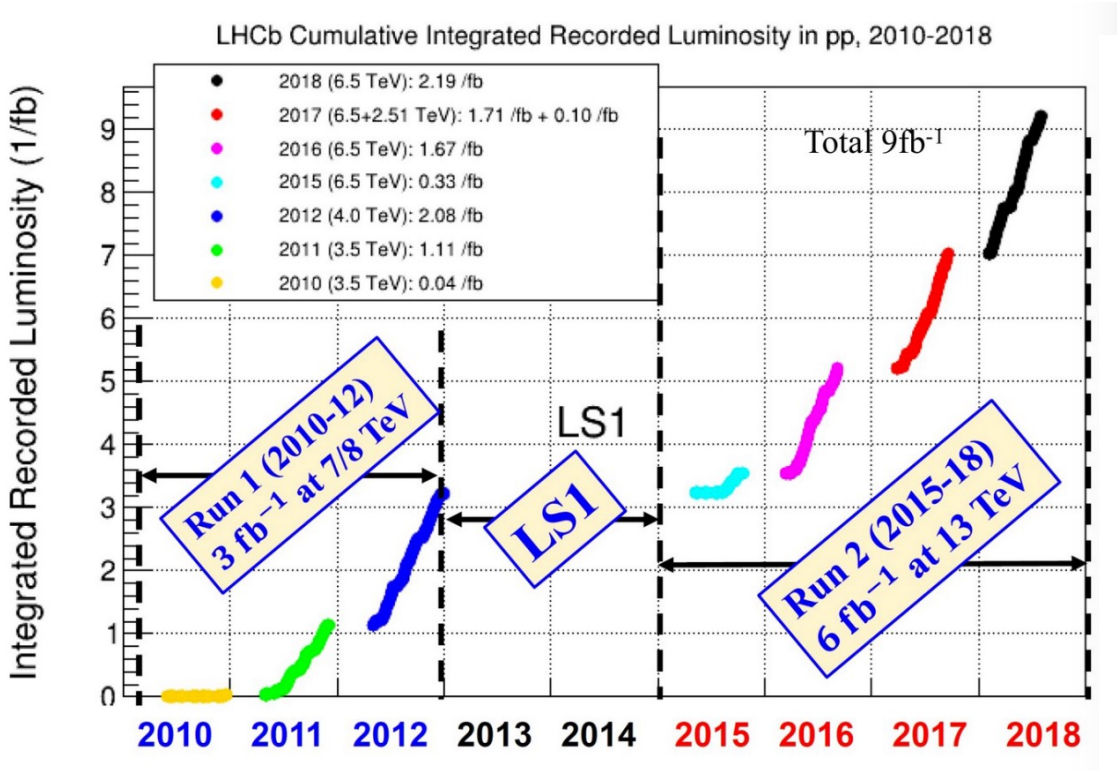
A single-arm forward region spectrometer ($2 < \eta < 5$)

Aiming for precision measurements in b, c flavor sectors

Lower instantaneous luminosity

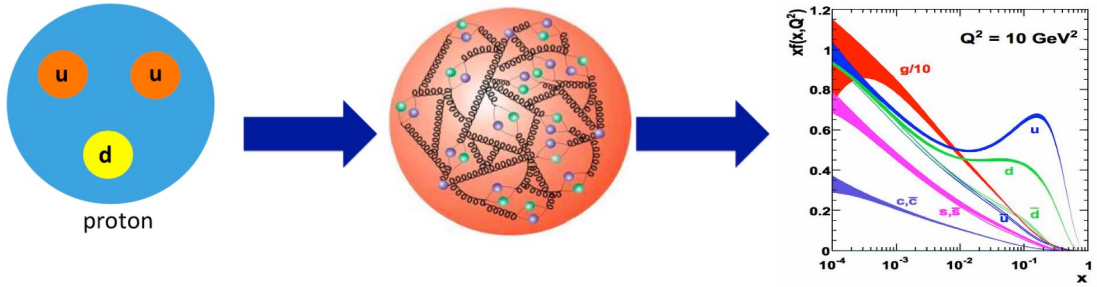
JHEP 3 (2015) S08005





Parton Distribution Functions

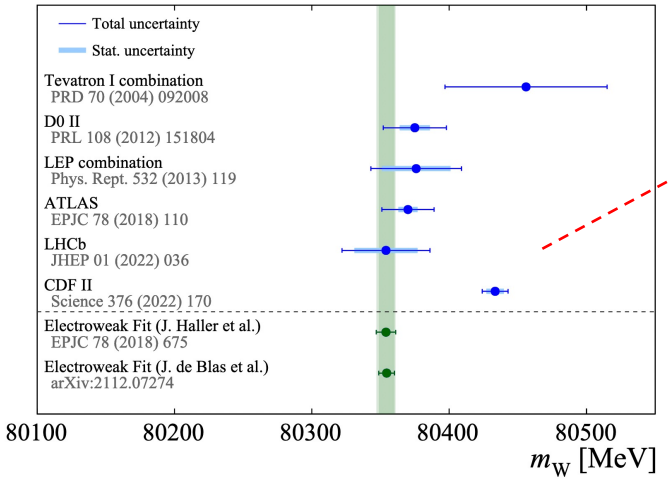
Parton Distribution Functions (PDFs) is an essential input for most of measurements at the Large Hadron Collider



PDFs can not be directly calculated, must be determined using experimental inputs and are generally extracted from a global analysis of high energy scattering data

- Many precision measurements are dominated by the PDFs uncertainty

LHCb-FIGURE-2022-003



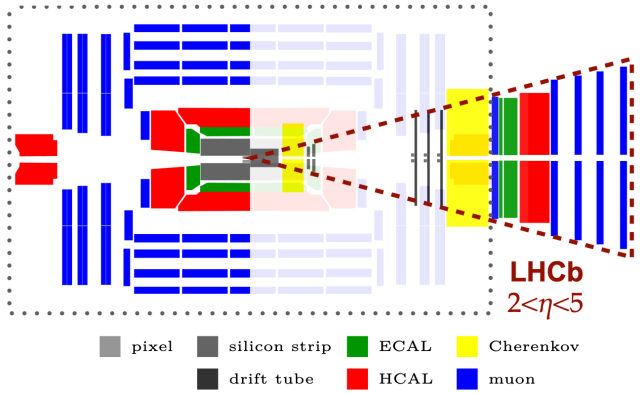
Science 376(2022) 170

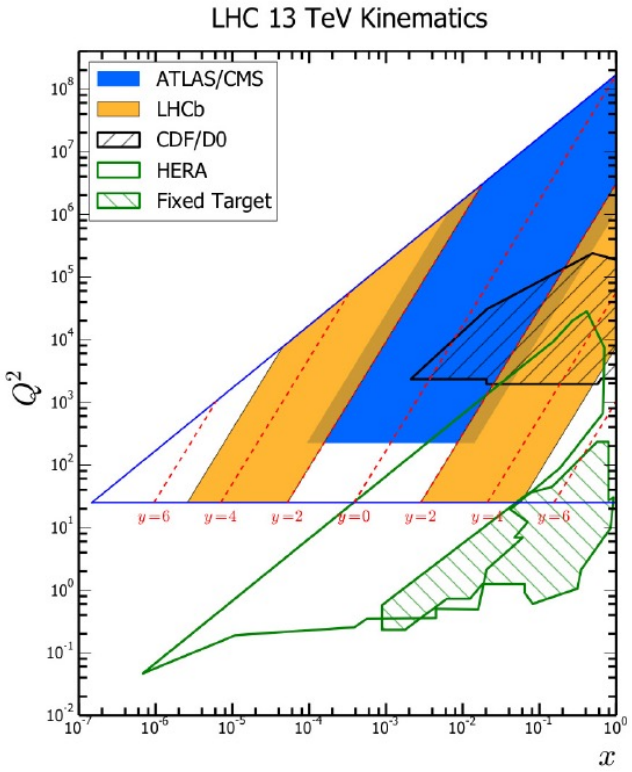
Source	Uncertainty (MeV)
Lepton energy scale	3.0
Lepton energy resolution	1.2
Recoil energy scale	1.2
Recoil energy resolution	1.8
Lepton efficiency	0.4
Lepton removal	1.2
Backgrounds	3.3
p_T^Z model	1.8
p_T^W/p_T^Z model	1.3
Parton distributions	3.9
QED radiation	2.7
W boson statistics	6.4
Total	9.4

LHCb data is sensitivity to PDFs

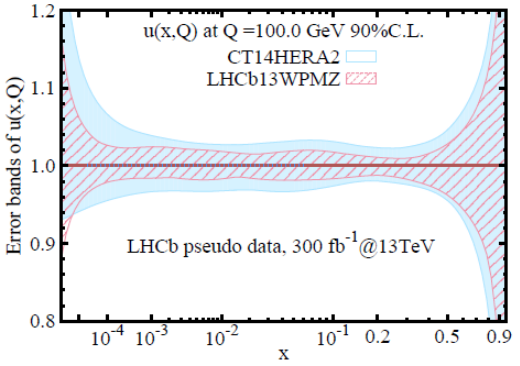
LHCb forward acceptance provides very interesting data to constraint the proton PDFs

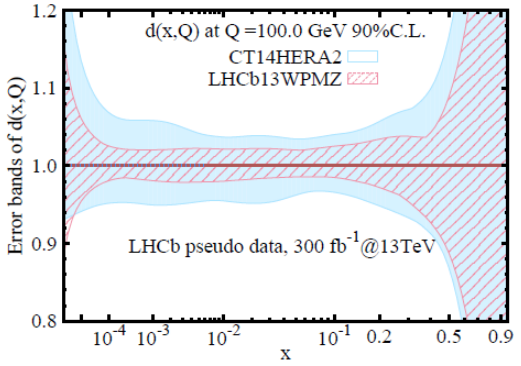
ATLAS, CMS and LHCb are complementary phase space to study electroweak processes

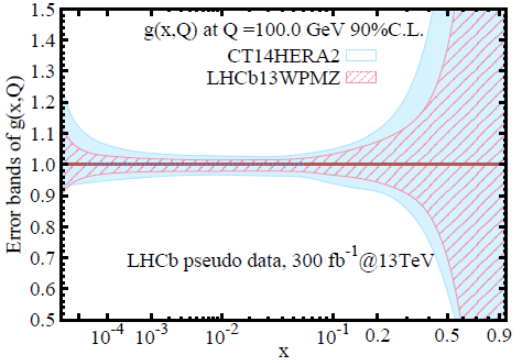


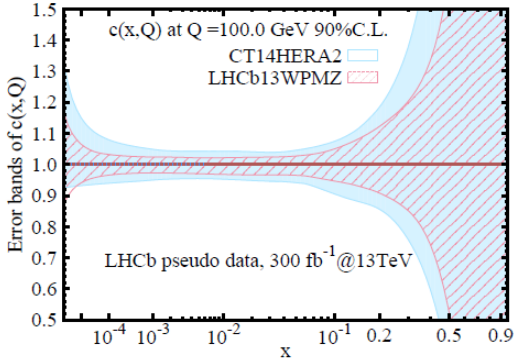


Chinese Phys. C **45** 023110









Recent measurements overview

2022

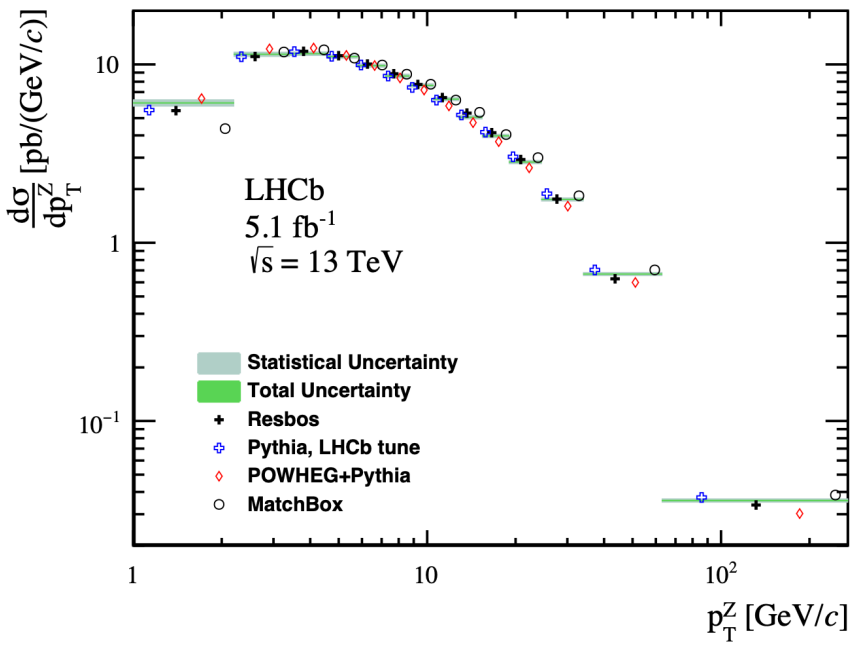
- Measurement of forward Z production in pp collisions at $\sqrt{s} = 13$ TeV
- Z angular coefficients measurement in the forward region in pp collisions at $\sqrt{s} = 13$ TeV
- Z production in association with charm in the forward region in pp collisions at $\sqrt{s} = 13$ TeV
- W mass measurement

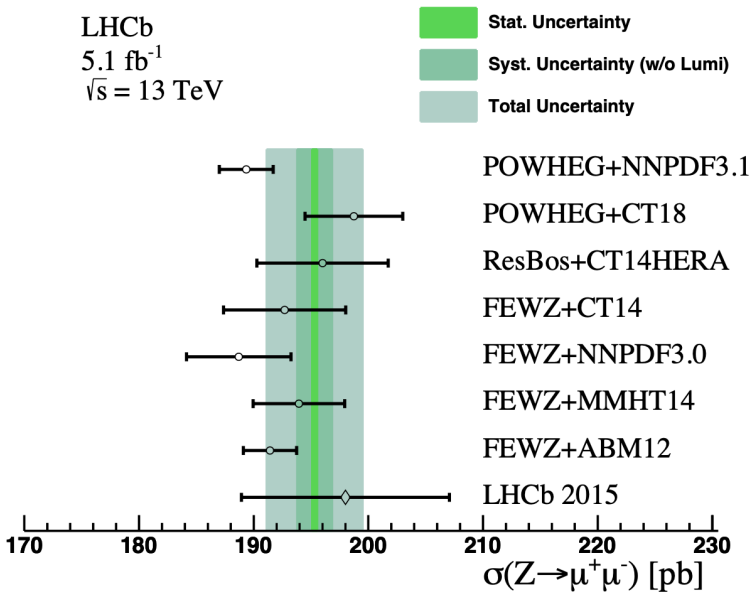
2023

- Measurement of forward Z production in pp collisions at $\sqrt{s} = 5.02$ TeV
- Search for W/Z boson rare decays

Measurement of forward Z production at $\sqrt{s} = 13$ TeV

JHEP 07 (2022) 26



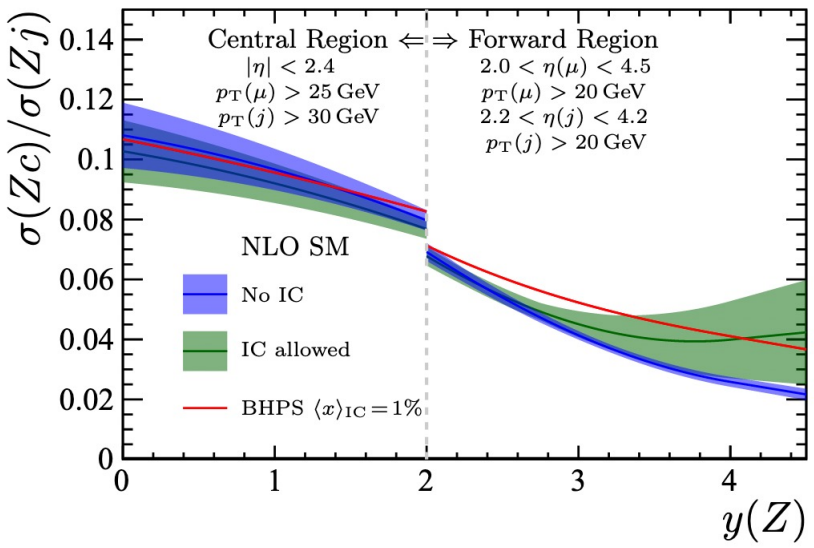


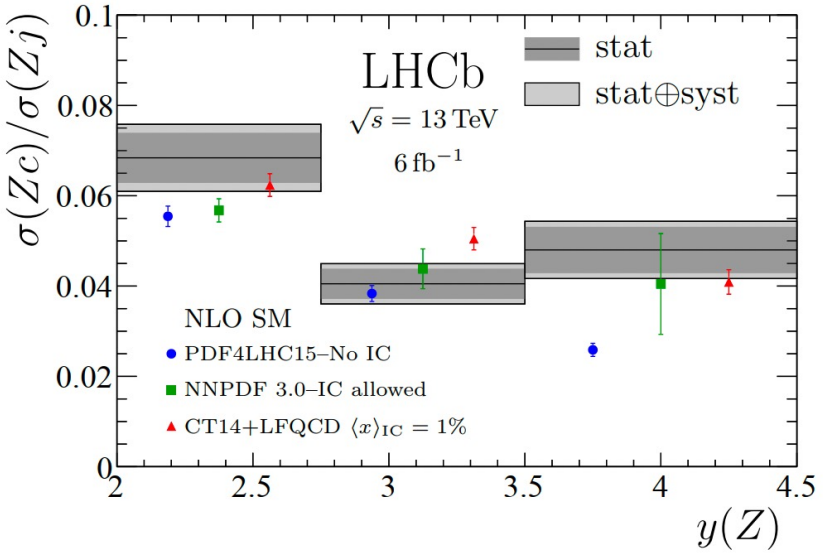
- $5.1\ \mathrm{fb}^{-1}$ of 13 TeV data used
- Forward region $2 < \eta < 4.5$
- Differential and double differential cross section are measured

$$\sigma(Z \to \mu^+\mu^-) = 195.3 \pm 0.2(\mathrm{stat}) \pm 1.5(\mathrm{sys}) \pm 3.9(\mathrm{lumi})\ \mathrm{pb}$$

Z boson produced in association with charm in the forward region

Phys. Rev. Lett. 128 (2022) 082001





- Using 6 fb^{-1} of 13 TeV data
- Inconsistent with No-Intrinsic charm content theory at $> 3\sigma$
- Incorporating forward results into a global analysis should strongly constrain the large-x charm PDFs
- Current results are statistically limited

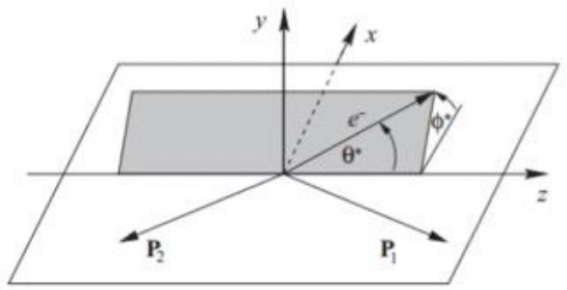
Z angular coefficients measurement in the forward region

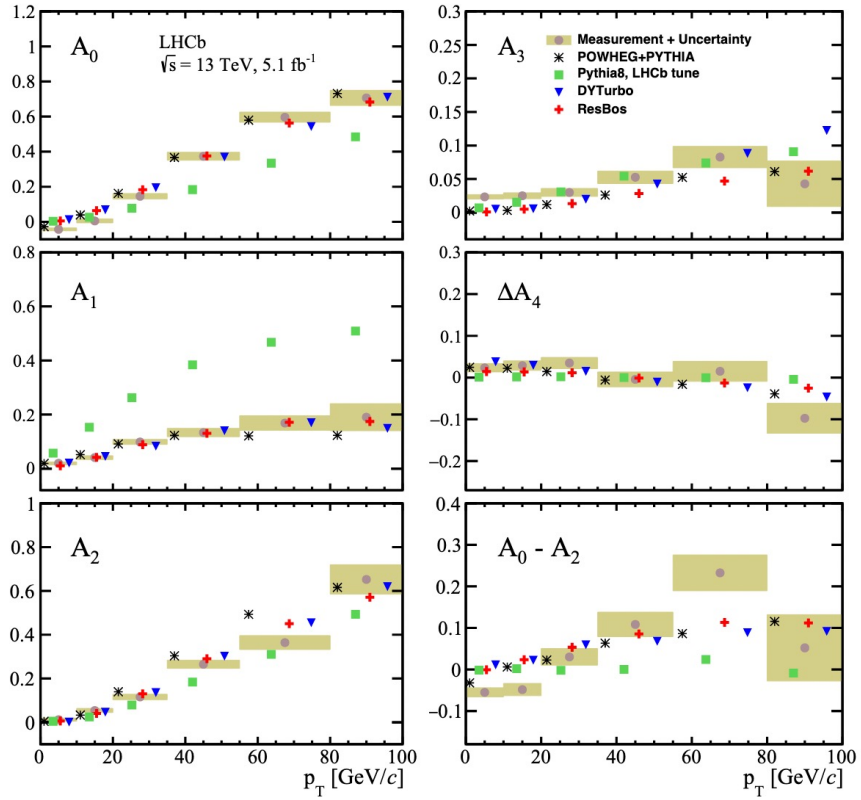
Phys. Rev. Lett. 129 (2022) 091801

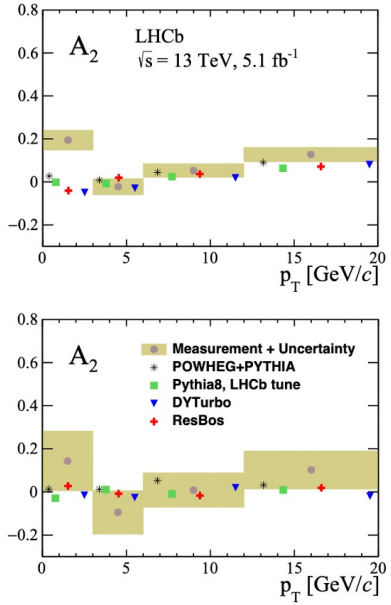
- The kinematic distribution of the final-state leptons provides a direct probe of the polarization of the intermediate gauge boson
- A_i: the ratio of helicity dependent cross-section over the unpolarized cross-section

$$\frac{d\sigma}{dP_T^2 dy d\cos\theta d\phi} \propto (1+\cos^2\theta) + \frac{1}{2}A_0(1-3\cos^2\theta) + A_1\sin 2\theta\cos\phi + \frac{1}{2}A_2\sin^2\theta\cos 2\phi + A_3\sin\theta\cos\phi + A_4\cos\theta + A_5\sin^2\theta\sin 2\phi + A_6\sin 2\theta\sin\phi + A_7\sin\theta\sin\phi$$

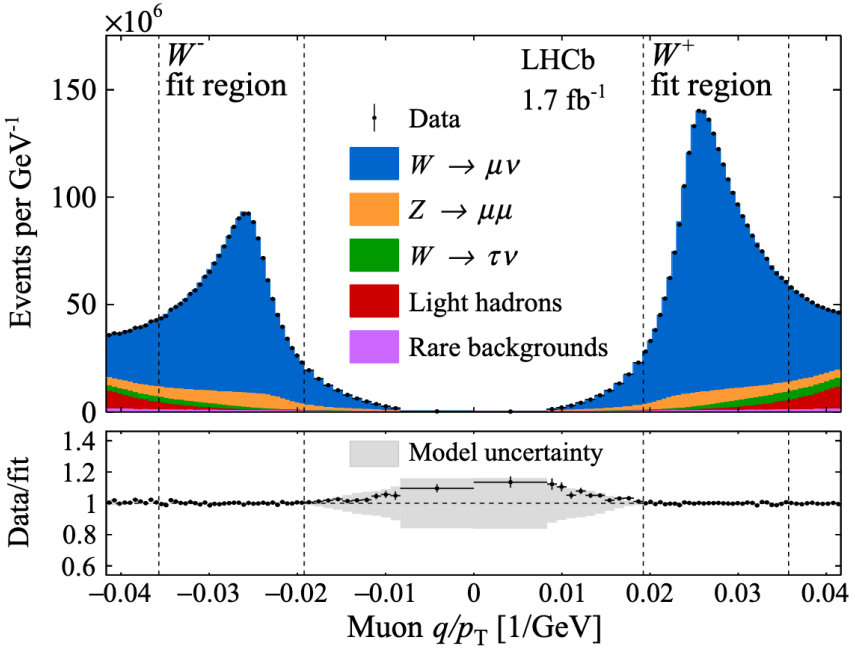
- $(1+\cos^2\theta)$ → LO term
- $\frac{1}{2}A_0(1-3\cos^2\theta)$ → $\cos^2\theta$: higher order term
- $A_1\sin 2\theta\cos\phi + \frac{1}{2}A_2\sin^2\theta\cos 2\phi + A_3\sin\theta\cos\phi$ → (θ, ϕ) terms
- $A_4\cos\theta$ → LO term : determine A_{fb}
- $A_5\sin^2\theta\sin 2\phi + A_6\sin 2\theta\sin\phi + A_7\sin\theta\sin\phi$ → very small terms



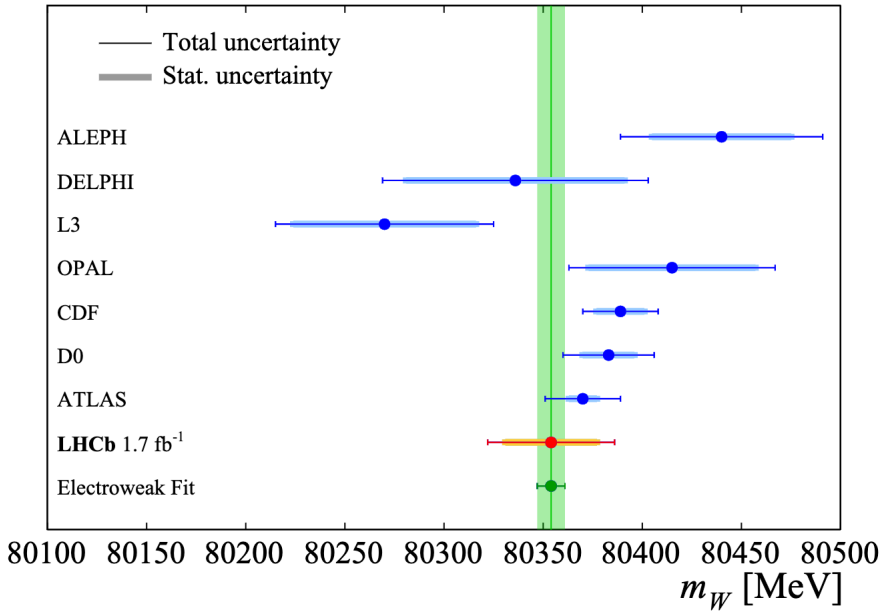




Measurement of W boson mass



JHEP 01 (2022) 036

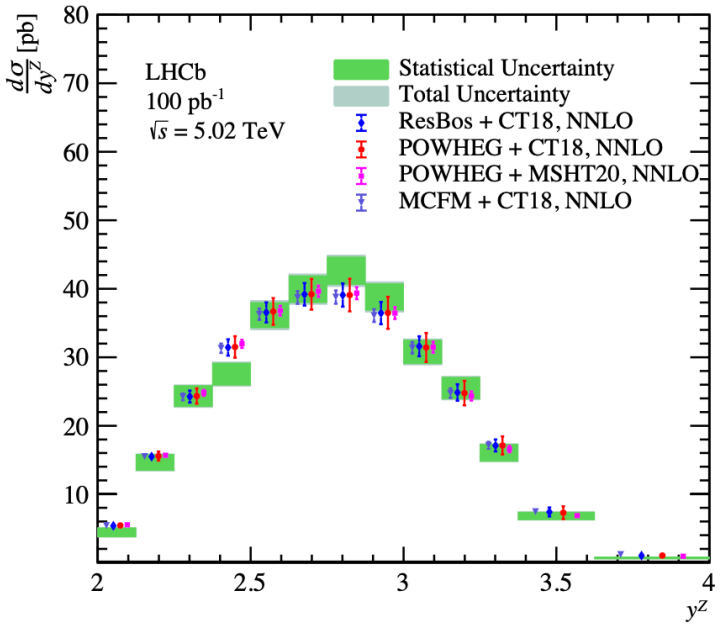


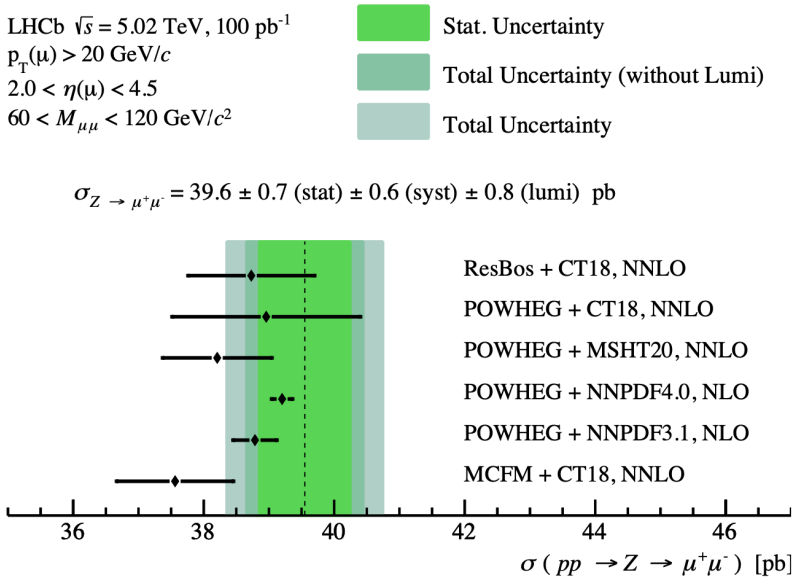
- 1.7 fb^{-1} of 13 TeV data used
- Measured W boson mass

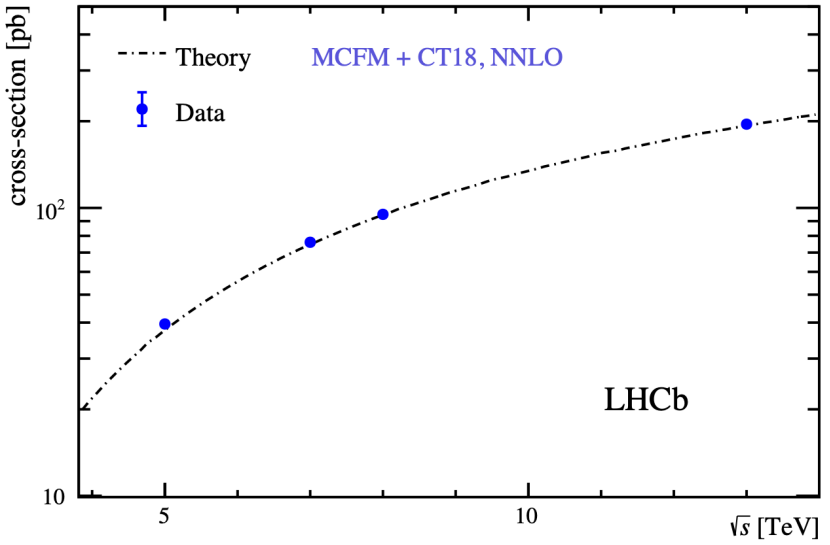
$$m_W = 8035 \pm 23(\mathrm{stat}) \pm 10(\mathrm{exp}) \pm 17(\mathrm{theory}) \pm 9(\mathrm{PDFs})\ \mathrm{MeV}$$

Measurement of forward Z production at $\sqrt{s} = 5.02$ TeV

arXiv:2112.07458







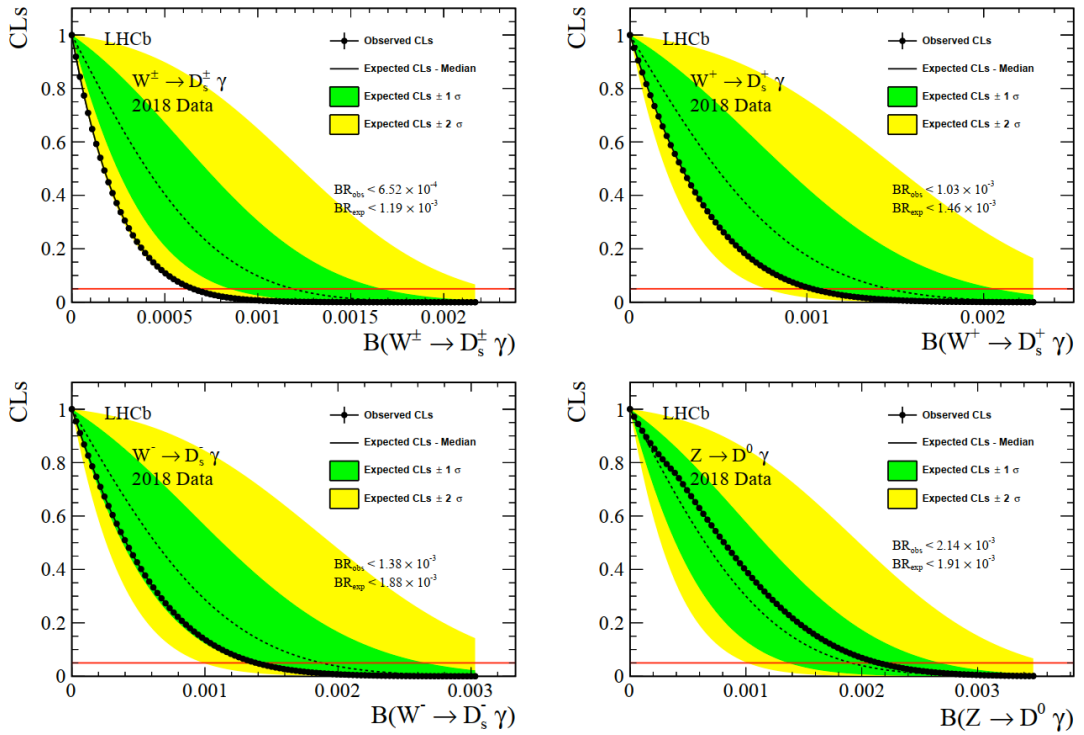
- 100 pb^{-1} of 13 TeV data used
- Forward region $2 < \eta < 4.5$
- Differential and double differential cross section are measured

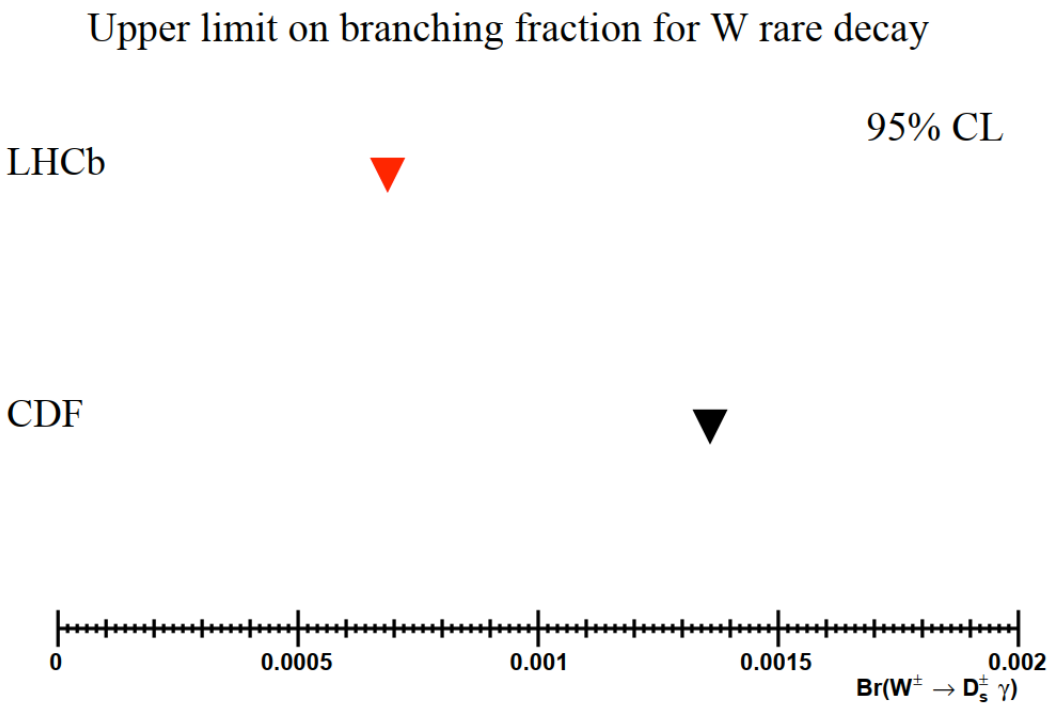
$$\sigma(Z \to \mu^+\mu^-) = 39.6 \pm 0.7(\mathrm{stat}) \pm 0.6(\mathrm{sys}) \pm 0.8(\mathrm{lumi})\ \mathrm{pb}$$

Search for W/Z boson rare decays

Chinese Phys. C **47** 093002

The upper limit of $W^{\pm} \to D_s^{\pm}\gamma$ is set at 6.5×10^{-4} and 2.1×10^{-3} for $Z \to D^0\gamma$ at 95% CL using the CLs Method.





Conclusions

- LHCb performed measurements of EW in the forward region of pp collisions
- It provide unique tests of the Standard Model and constraints to the PDFs
- A lot of work is in progress for new exciting measurements

Thanks for your attention.