Measurements in Association with Electroweak Bosons at LHCb

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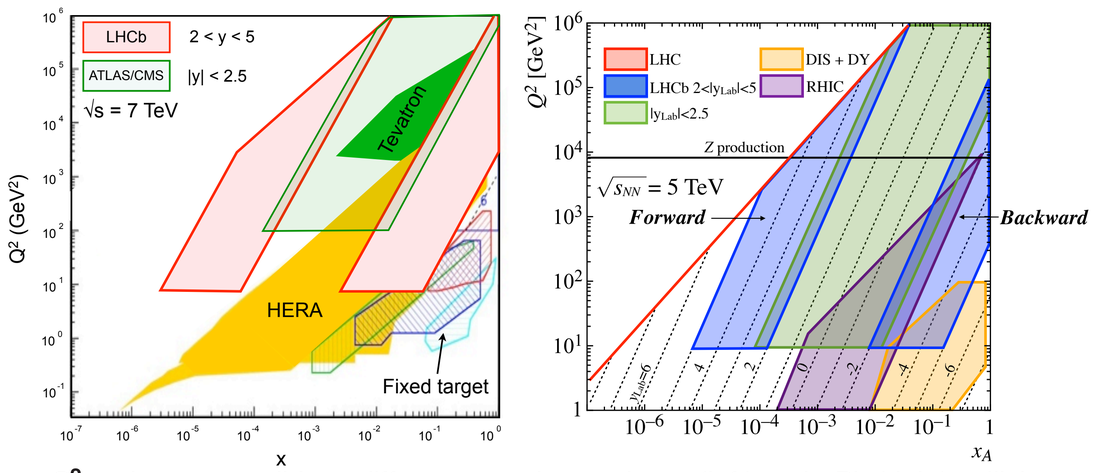
Motivation

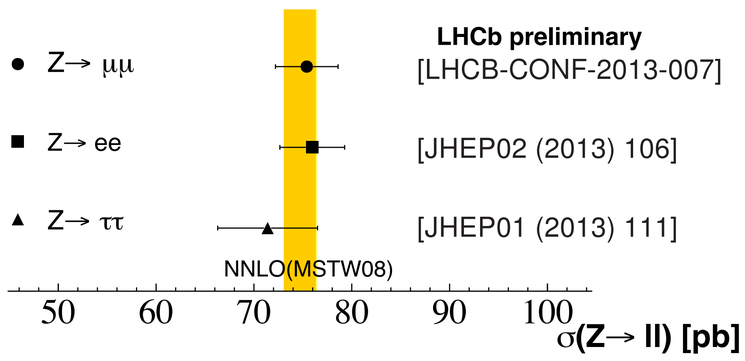
The LHCb is measuring the production of ***W*** and ***Z*** bosons in the forward direction. The production of electroweak bosons in the LHCb acceptance implies an asymmetry between the fractional momenta, $x_{1,2}$, of the two partons taking part in the hard scatter.
This allows to test x to very low (smaller than $\mathcal{O}(10^{-4})$) as well as very high (larger than $\mathcal{O}(10^{-1})$) values. These measurements thus serve as important inputs to the determination of parton density function sets.



x-Q^2 regions accessible to different experiments in pp (left) and pPb (right) collisions.
Forward refers to the direction of the proton, backward to the direction of the lead beam.

Inclusive *Z* Production

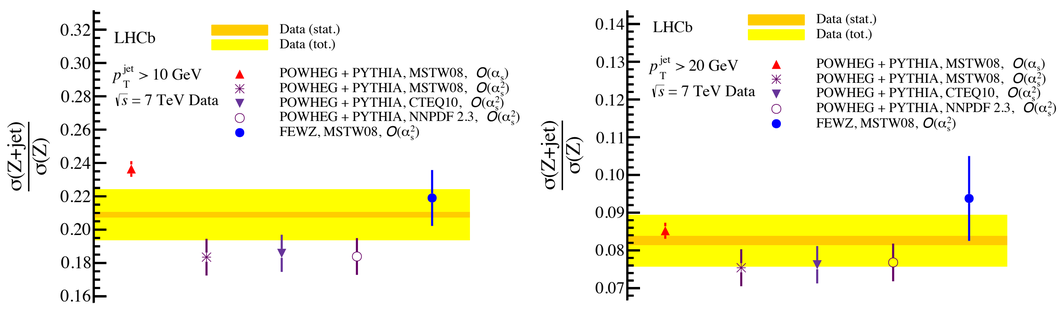
LHCb has measured the inclusive ***Z*** production cross section in the di-muon, the di-electron and the di-tau ($\tau_\mu\tau_\mu$, $\tau_\mu\tau_e$, $\tau_\mu\tau_h$, $\tau_e\tau_h$) final state for a centre-of-mass energy of **7** TeV.
The fiducial region of the measurements is defined by the cuts $\mathbf{2.0} < \eta_\ell < \mathbf{4.5}$, $p_\mathrm{T}(\ell) > \mathbf{20}$ GeV/c and $\mathbf{60} < m_{\ell\ell} < \mathbf{120}$ GeV/c^2, which also define the ***Z*** candidates in the other measurements presented here.



Summary of the measured inclusive ***Z*** cross sections in the di-muon, di-electron and di-tau channel compared with a prediction at next-to-next-to-leading order

Z + Jet Production [JHEP01 (2014) 033]

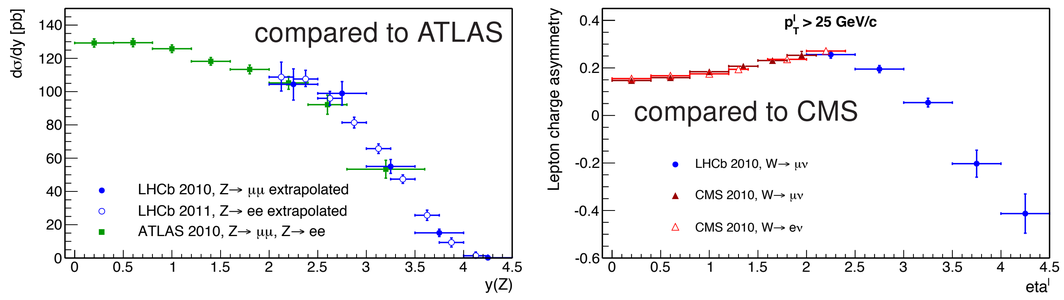
Jet production associating a ***Z*** boson in the forward direction is sensitive to parton radiation and allows to test different showering models.
The jets are reconstructed by the anti-kT algorithm with a cone size of $R = \mathbf{0.5}$.
The main systematic uncertainties come from the jet energy scale and the jet reconstruction efficiency.



Z+jet cross section for (left) $p_\mathrm{T}(\mathrm{jet}) > \mathbf{10}$ GeV/c and (right) $p_\mathrm{T}(\mathrm{jet}) > \mathbf{20}$ GeV/c normalized to the ***Z*** cross section compared to predictions at different orders of α_s

Complementarity to other LHC Experiments

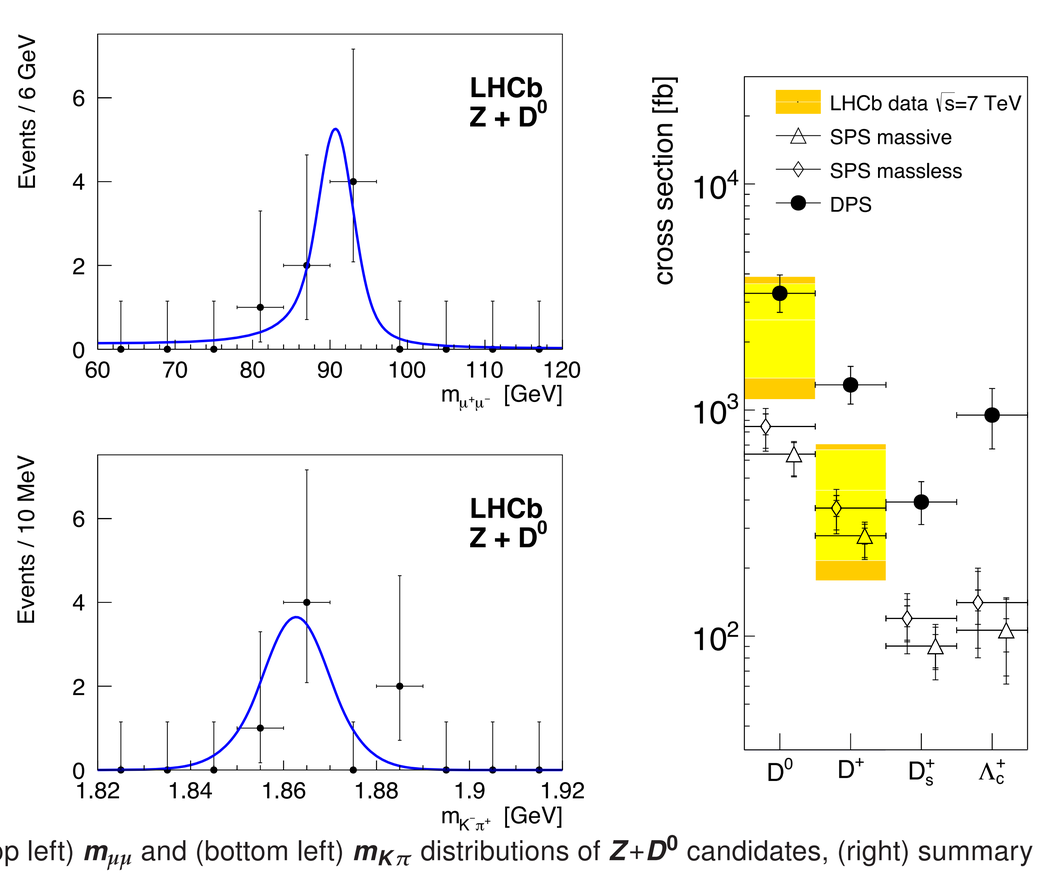
LHCb covers a phase space ($\mathbf{2.0} < y < \mathbf{4.5}$) complementary to ATLAS and CMS ($|y| < \mathbf{2.5}$) leading to an enlarged rapidity range from $\mathbf{0} < |y| < \mathbf{4.5}$ tested by the LHC experiments. The measured cross sections in the overlap regions are in good agreement between the experiments.



Differential cross section measurements by LHCb of (left) ***Z*** production compared with ATLAS measurements and (right) ***W*** charge asymmetry compared with CMS measurements

Z and *D* Meson Production [JHEP04 (2014) 091]

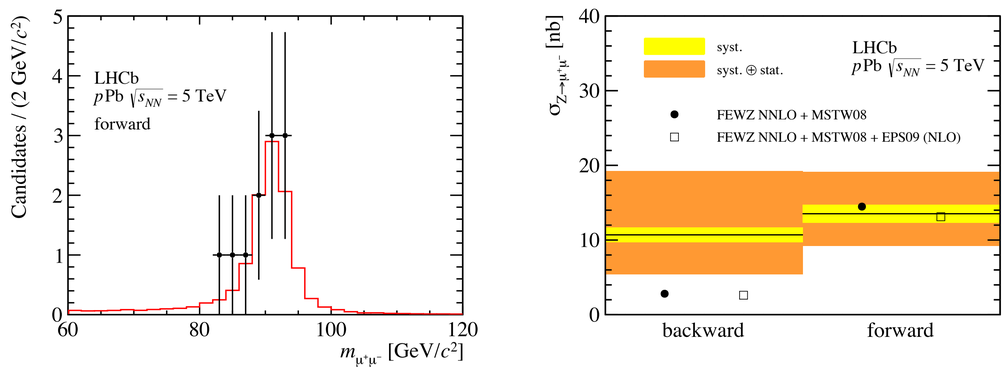
LHCb has made the first observation of ***Z***+***D*** production with the ***D*** mesons reconstructed in the $D^0 \to K^-\pi^+$ and $D^+ \to K^-\pi^+\pi^+$ decay channels ($\mathbf{2.0} < \eta_D < \mathbf{4.5}$, $\mathbf{2} < p_\mathrm{T}(D) < \mathbf{12}$ GeV/c). This measurement tests the charm content of the proton and models describing Double Parton Scattering.



(Top left) $m_{\mu\mu}$ and (bottom left) $m_{K\pi}$ distributions of ***Z***+D^0 candidates, (right) summary of the measured ***Z***+***D*** production cross sections

Z Production in Proton-Lead Collisions [arXiv:1406.2885]

Based on a data sample of $\mathbf{1.6}$ nb^{-1} of proton-lead collisions LHCb measured for the first time the inclusive ***Z*** production cross section in the di-muon channel at $\sqrt{s_{NN}} = \mathbf{5}$ TeV. Separate measurements in the direction of the proton beam (forward) and lead beam (backward) have been done, which are in agreement with predictions.



(Left) $m_{\mu\mu}$ distributions of ***Z*** candidates in the forward direction, (right) summary of the measured ***Z*** production cross sections in pPb collisions

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