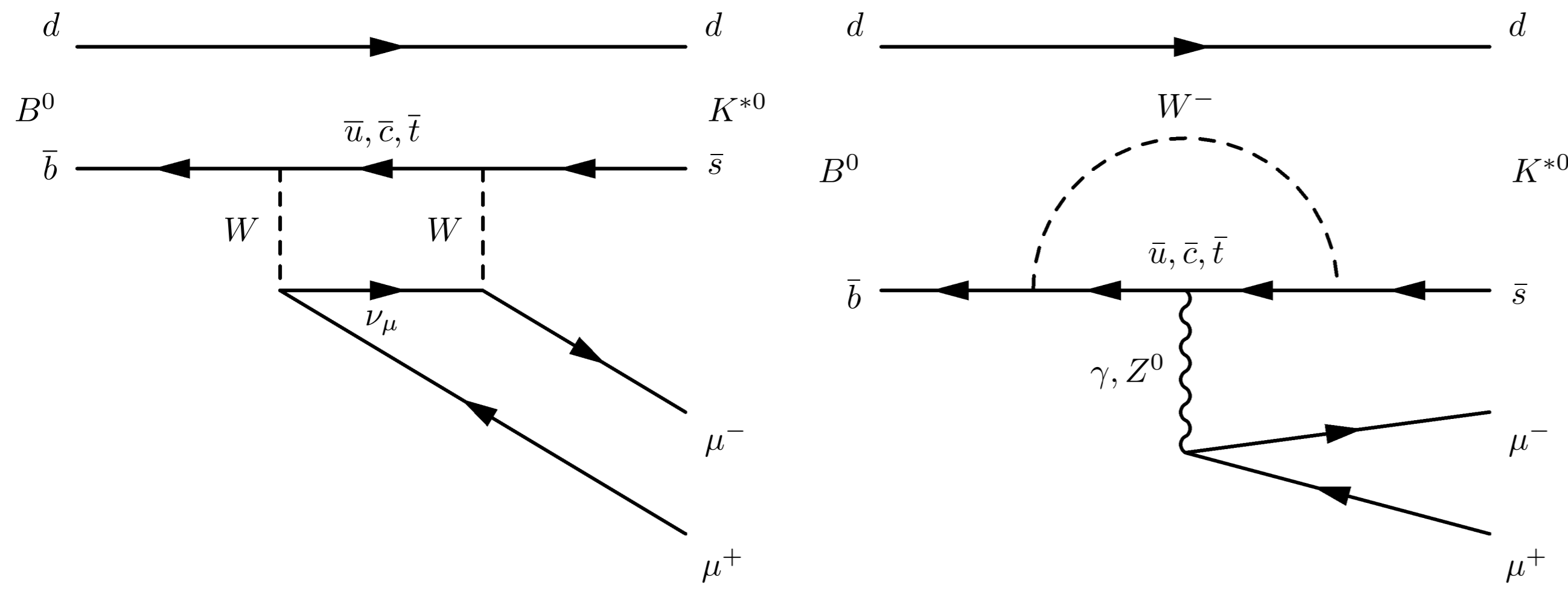


Introduction

Rare decays are an excellent laboratory to probe Standard Model. New physics contributions would have amplitude comparable with the expected one and they may be observed through their influence on these processes.

The decay $B^0 \rightarrow K^*(892)^0 \mu^+ \mu^-$ is particularly appropriate, thanks to

- ▶ precise theoretical prediction of the decay angular parameters, especially in the low dimuon invariant mass region.
- ▶ small branching ratio ($\sim 10^{-6}$), since the tree level process is forbidden and the leading order contribution is given by the 1-loop diagrams shown in figure;



The decay parameters studied in this analysis are

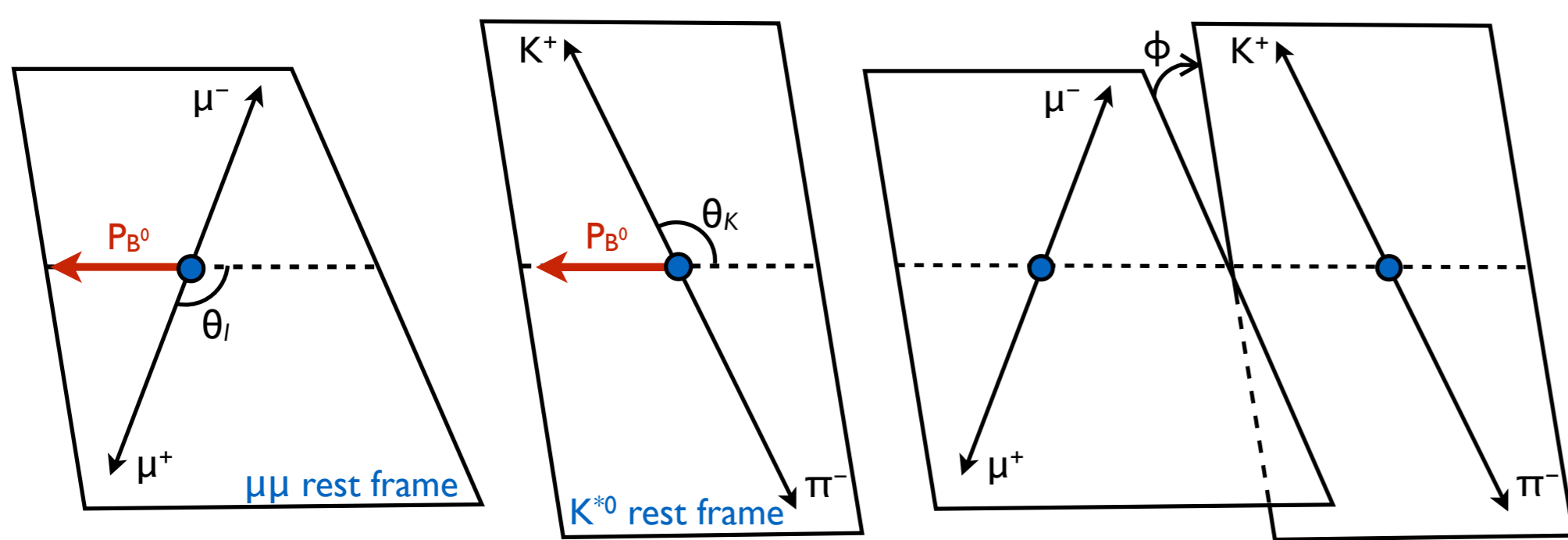
- ▶ F_L , the fraction of K^{*0} produced with longitudinal polarization;
- ▶ A_{FB} , the forward-backward asymmetry of the muons;
- ▶ dB/dq^2 , the differential branching ratio.

All of them are determined as a function of the dimuon invariant mass squared, q^2 .

Angular variables

This 4-body decay is completely described by q^2 and three angular variables:

- ▶ the angle between the kaon momentum and the direction opposite to the B^0 in the K^{*0} rest frame, θ_K ;
- ▶ the angle between the positive (negative) muon momentum and the direction opposite to the B^0 (\bar{B}^0) in the dimuon rest frame, θ_I ;
- ▶ the angle between the plane containing the two muons and the plane containing the kaon and the pion, ϕ ;



Fit strategy

The parameter we are interested in does not depend on ϕ , so we can integrate it out. The decay rate, as a function of the remaining variables is:

$$\frac{1}{\Gamma} \frac{d^3\Gamma}{d \cos \theta_K d \cos \theta_I dq^2} = \frac{9}{16} \left\{ \left[\frac{2}{3} F_S + \frac{4}{3} A_S \cos \theta_K \right] (1 - \cos^2 \theta_I) + (1 - F_S) \left[2F_L \cos^2 \theta_K (1 - \cos^2 \theta_I) + \frac{1}{2} (1 - F_L) (1 - \cos^2 \theta_K) (1 + \cos^2 \theta_I) + \frac{4}{3} A_{FB} (1 - \cos^2 \theta_K) \cos \theta_I \right] \right\}$$

where F_S is the fraction of S-wave contamination in $K\pi$ production and A_S is the interference contribution between S-wave and P-wave. For each q^2 bin, a simultaneous unbinned maximum likelihood fit to the B^0 mass, $\cos \theta_K$ and $\cos \theta_I$ distributions is performed. From this fit the yields, the mass shape parameters and the angular parameters are obtained.

Events and data samples

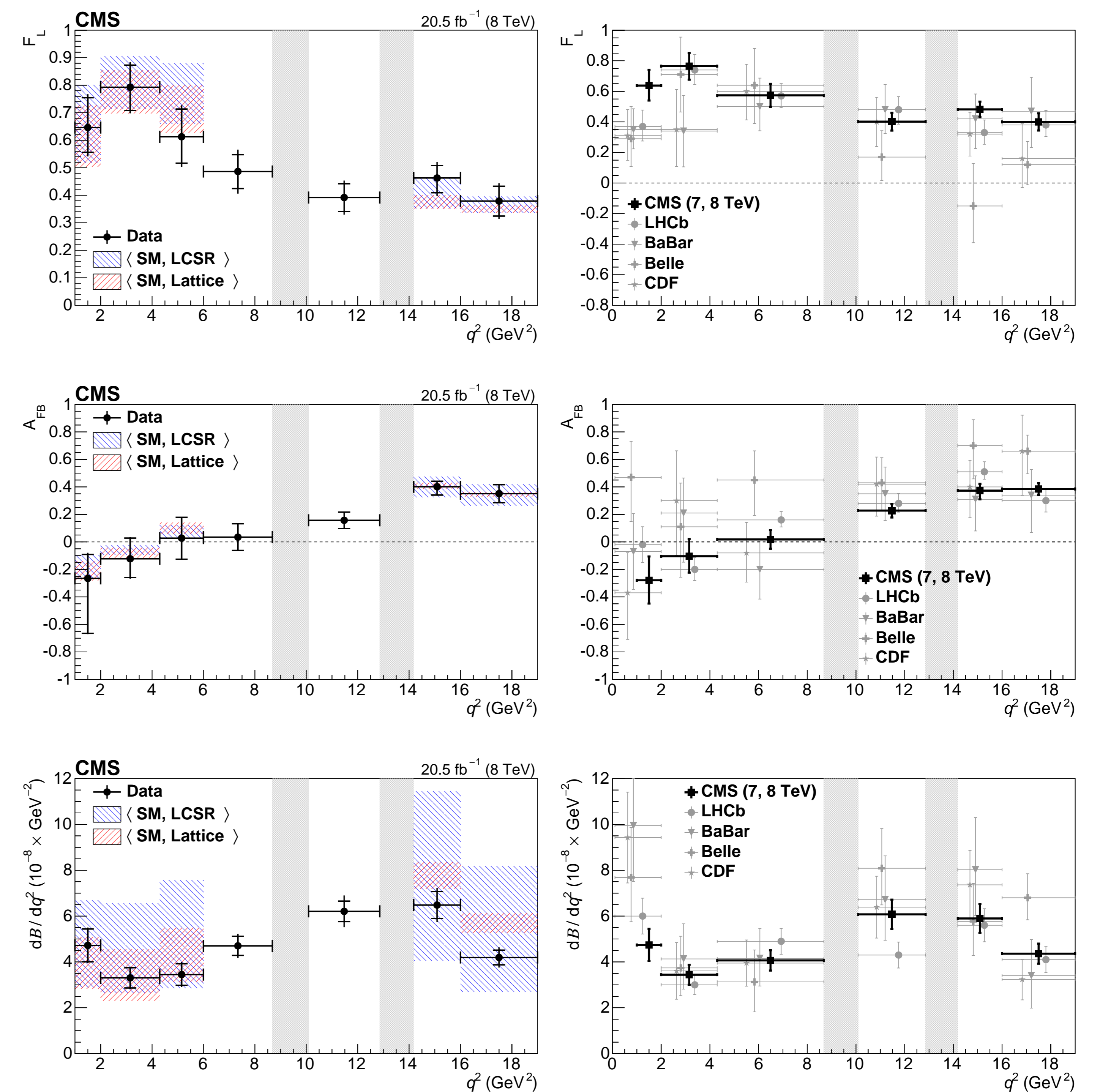
The dataset used [1] is collected from pp collisions at a center-of-mass energy of 8 TeV, corresponding to an integrated luminosity of 20.5 fb^{-1} . The K^{*0} is reconstructed through its decay to $K^+ \pi^-$, as well as the charge conjugate state.

- ▶ **Signal** is composed by $B^0 \rightarrow K^{*0} \mu \mu$ events, where
 - ▶ the two muons are well reconstructed and have invariant mass far from J/ψ and ψ' resonances;
 - ▶ the K and π have an invariant mass near the K^{*0} ;
- ▶ **mistagged** events are signal decays where the K and π tracks are associated to the wrong hadron. The contamination from mistagged events is treated as a separate contribution in the angular fit, since the corresponding PDF depends on the angular parameters in a different way;
- ▶ **background** events are divided in
 - ▶ resonant background, composed of $B^0 \rightarrow K^{*0} J/\psi$ or $B^0 \rightarrow K^{*0} \psi'$ events that elude the mass cut;
 - ▶ combinatorial background, where the tracks do not come from a single B^0 ;
- ▶ **normalization sample** is composed of the events in the J/ψ resonance, with $8.68 < q^2 < 10.09 \text{ GeV}^2$. Since the branching ratio of the $B^0 \rightarrow K^{*0} J/\psi$ decay is well known, this sample is used to normalize the branching ratio of the non-resonant decay.
- ▶ **control sample** is composed of the events in the J/ψ resonance, with $12.86 < q^2 < 14.18 \text{ GeV}^2$. It is used to control the background contamination, as given by the simulations.

Results

In the following plots the results for the interesting parameters are shown.

Note the predominance of the statistical error (inner error bars) and the good agreements with the measurements from other experiments [2–7] and with the SM predictions [8, 9].



References

- [1] CMS Collaboration, CMS-BPH-13-010, CERN-PH-EP-2015-178
- [2] CMS Collaboration, *Phys. Lett. B* **727** (2013) 77
- [3] LHCb Collaboration, *JHEP* **08** (2013) 131
- [4] BaBar Collaboration, *Phys. Rev. D* **86** (2012) 032012
- [5] CDF Collaboration, *Phys. Rev. Lett.* **108** (2012) 081807
- [6] CDF Collaboration, *Phys. Rev. Lett.* **106** (2011) 161801
- [7] Belle Collaboration, *Phys. Rev. Lett.* **103** (2009) 171801
- [8] C. Bobeth, G. Hiller, and D. van Dyk, *JHEP* **07** (2010) 098
- [9] C. Bobeth, G. Hiller, and D. van Dyk, *Phys. Rev. D* **87** (2012) 034016