LHCb Summary: Reach in Rare Decay Searches

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Content

The goal of this talk is to give an overview of the LHCb program with rare decays.

I will present
o What we are doing
o What we intend to do
o What we might do if you push us to do it

I will not present
o What we did not think about doing yet

Please do not hesitate to interrupt and trigger discussions: the relevant people are in the room.

BF of $B_s^0 \to \mu\mu$ and $B \to \mu\mu$

o LHCb published a paper on 37pb^{-1} PLB699(300)

o We have a preliminary result on 370pb^{-1} of 2011 data combined with the 2010 data (to be submitted to PLB soon)

$$\mathrm{BF}(B_s^0 \to \mu\mu) < 1.4 \times 10^{-8}$$
$$\mathrm{BF}(B \to \mu\mu) < 3.2 \times 10^{-9}$$

at 95% CL

o We will update the analysis on 1.1fb^{-1} for the Winter conferences.

What we can do is a two-step process:

- constrain the BFs (and thus the Wilson coefficients)
- measure the BFs one after the other.

As soon as one is measured we can start constraining their ratio, which is of prime interest for the MFV scenario.

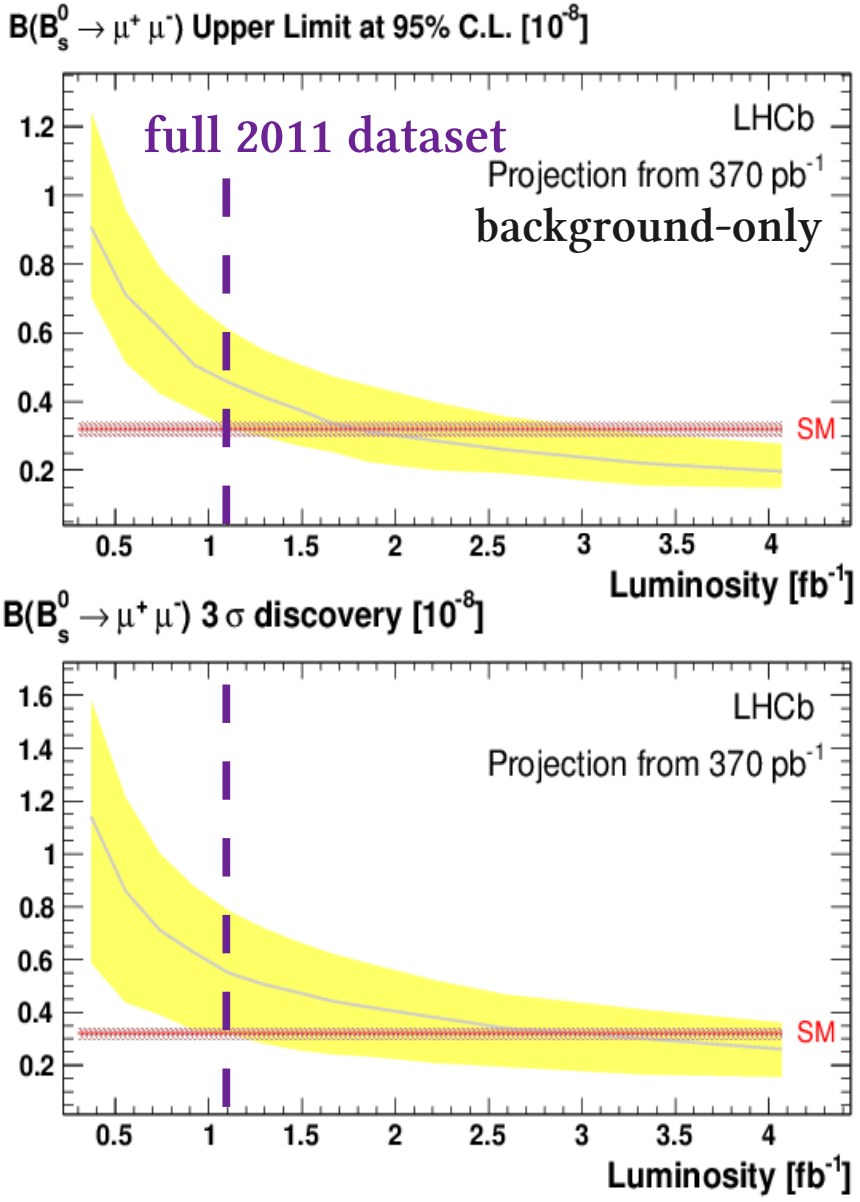
Note that while the BF of the B channel is about 30 times smaller than for the Bs in the SM, our sensitivity to this channel is only 8 times smaller due to the hadronisation probability.

Prospects for $B_s \to \mu\mu$

In case the signal is significantly lower than the SM, we can exclude BF down to the SM level with less than $2fb^{-1}$.

Note that we have on $370pb^{-1}$ a signal hint at 2sigma level: take the background-only hypothesis with care.

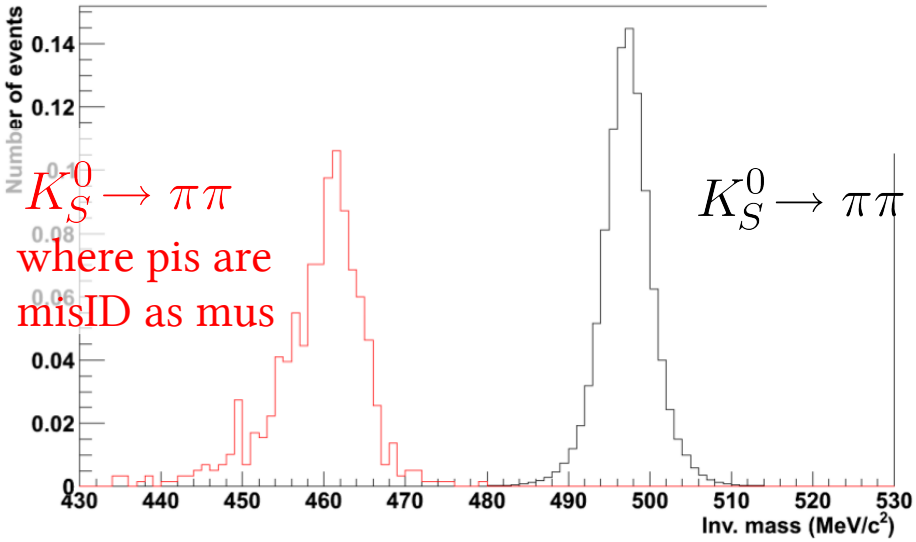
If a signal exist at the SM level we could make a 3sigma measurement by the Winter conferences.

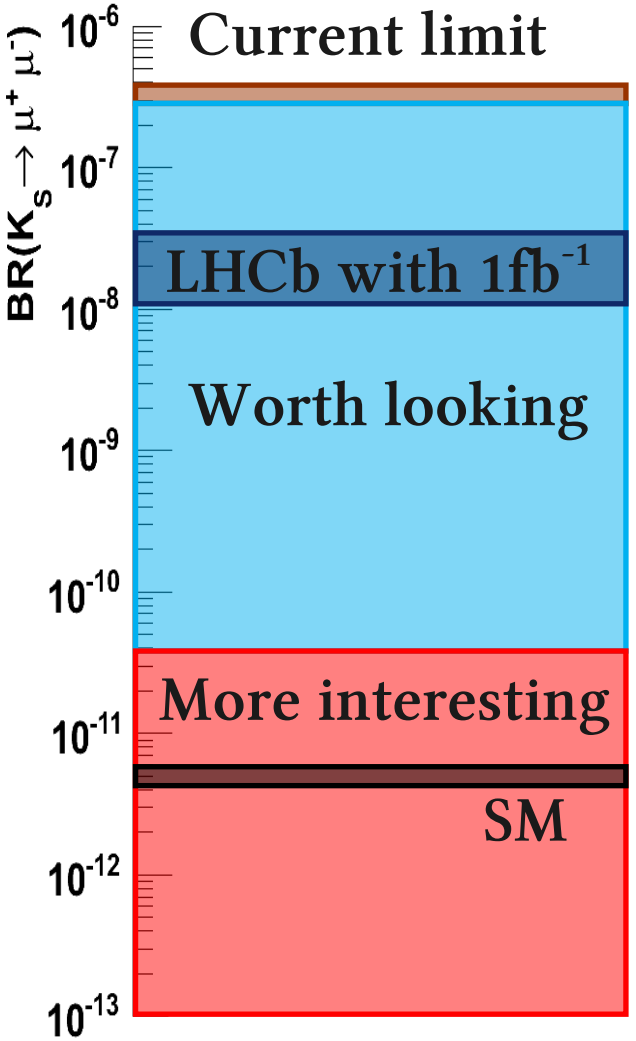


$K_S^0 \to \mu\mu$

In the SM $\mathrm{BF}(K_S^0 \to \mu\mu) \sim 5 \times 10^{-12}$,
up to few 10^{-11} in presence of NP.
Current limit is $\mathrm{BF} < 3.2 \times 10^{-7}$ at 90% CL

Analysis strategy similar as that of $B_s^0 \to \mu\mu$, using $K_S^0 \to \pi\pi$ as normalisation channel.



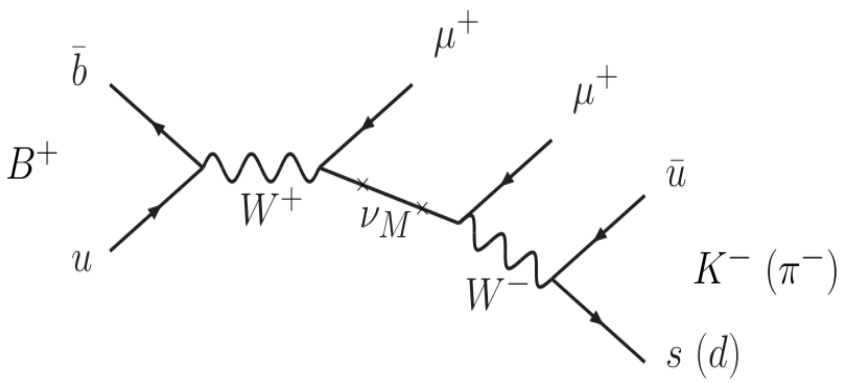


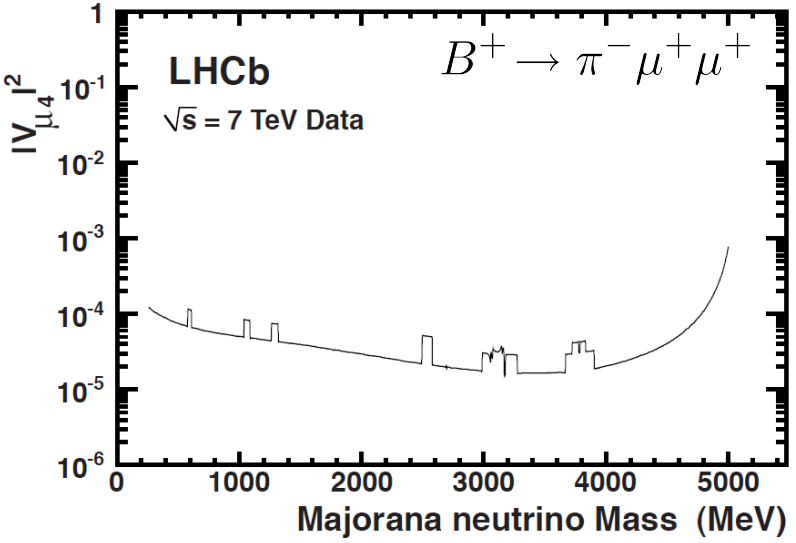
Search for Majorana neutrinos

Lepton Flavour Violating processes, forbidden in the SM, are possible if neutrinos are Majorana. Limit on the BF of such processes can be interpreted as limit on the coupling of Majorana heavy neutrinos to mu and W.

- in the $B^+ \to \pi^- \mu^+ \mu^+$ and $B^+ \to K^- \mu^+ \mu^+$ channels [hep-ex:1110.0730] submitted to PRL

- in $B^+ \to \pi^- \mu^+ \mu^+$, $B^- \to D_s^+ \mu^- \mu^-$, $B^- \to D^0 \mu^- \mu^- \pi^+$ $B^- \to D^+ \mu^- \mu^-$ and $B^- \to D^{*+} \mu^- \mu^-$
  To be submitted to PRD soon.





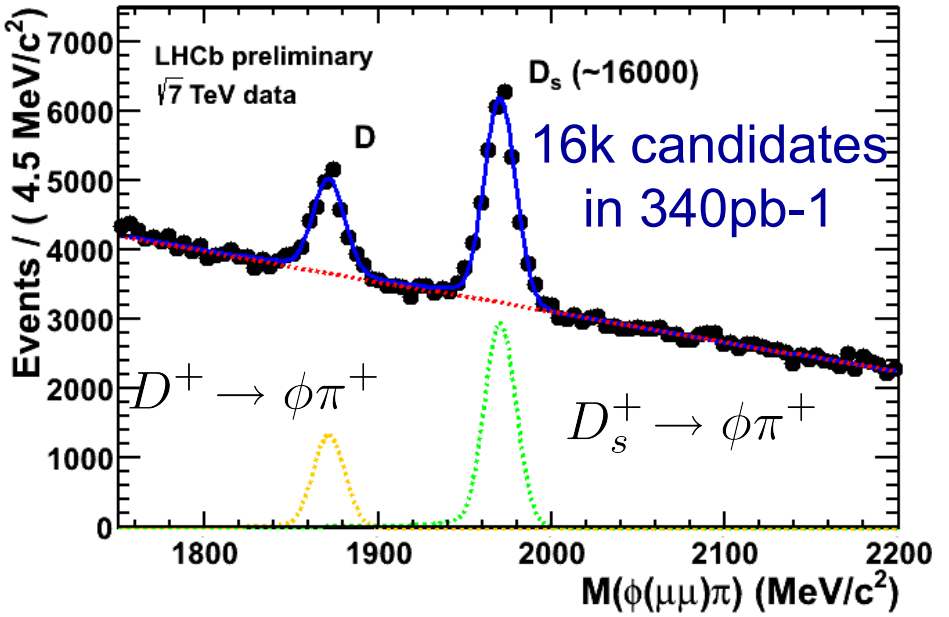
Non-existent in the SM. Allowing for neutrinos oscillation
$\mathrm{BF}(\tau \to \mu\mu\mu) \sim \mathcal{O}(10^{-54})$, up to $\mathcal{O}(10^{-10} - 10^{-8})$ BSM.

Current limit is $\mathrm{BF} < 2.1 \times 10^{-8}$ at 90% CL by Belle.

Analysis strategy similar as that of $B_s^0 \to \mu\mu$, using $D_s^+ \to \phi(\mu\mu)\pi^+$ as normalisation channel.
We see $5 - 7 \times 10^9$ taus per fb^{-1}.

Trigger eff. of 50%.

We expect interesting results for the Winter conferences and beyond.



Taus final states

Feasible at LHCb?

We have been concentrating on muonic final states because of their very high detection efficiency.
We recently had a closer look at the tau reconstruction in the $\tau \to \pi\pi\pi\nu$ channel. It is possible at LHCb, however the efficiency is low.

It is important for us at this point to get a feedback from the theory community on how impacting those decays are.

We started working on

$B_s^0 \to \tau\tau$ $B_s^0 \to \tau\mu$

Other ideas ?

Conclusions

o $B_{(s)} \to \mu\mu$, a paper to appear soon, update for the Winter. Observation of the Bs channel possible this Winter.

o Search for another FCNC $K_S^0 \to \mu\mu$ recently started.

o Two papers to appear soon on searches for Majorana neutrinos in LFV decays.

o Interesting prospects for $\tau \to \mu\mu\mu$ already by next year.

o Tau reconstruction possible, several channels under scrutiny.

o We are also looking at $B_s^0 \to \mu\mu\mu\mu$. In that context we see several $B_s^0 \to J/\psi(\mu\mu)\phi(\mu\mu)$ candidates in background-free environment.

o We are also studying rare decays in the charm realm. We expect a interesting result from $D^0 \to \mu\mu$ for the Winter conferences. We are also looking at $D^0 \to h\mu\mu$ and $D^0 \to KK\mu\mu$