B decays into lepton pairs (lepton = tau/muon)

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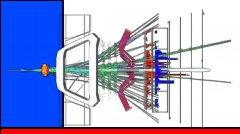


The current status

τ leptons offer a unique window to new observables and phenomena:

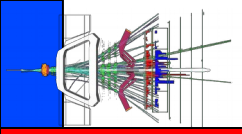
The comparison of a transition with τ leptons with its counterpart with muons or electrons allows stringent tests of lepton flavour universality (LFU) of SM

Number of hints that LFU is broken:
$R(K)=BR(B_d \to K\mu\mu)/BR(B_d \to Kee)=0.745+0.090-0.074+/-0.036$ by LHCb
Anomalies in angular distribution of $B \to K^*\mu\mu$ (P'_5) by LHCb
Ratio of experimental to theoretical $B_s \to \mu\mu$

If this indicates new physics in the lepton sector, effects might be largest for τ leptons

According to Glashow, Guadagnoli and Lane (1411.0565), non-LFU clear indicator of lepton flavour violation (LFV) → necessary to measure B to K*ll' and B_s to ll'
[However, this is disputed by Grinstein et al (1505.05164)]

Therefore necessary to measure ALL relevant lepton final states in these channels



Doctoral position demand

Experimental side a continuation of Alessandro's work ($3\pi 3\pi$):

Only measurement: BABAR hep-ex/0511015 - $BR(B_d \to \tau^+\tau^-) < 4.1 \times 10^{-3}$ @ 90% CL

LHCb reach with $3fb^{-1}$ ~10^{-3} (maybe better)

- $\tau\ \tau$: extend it to $3\pi\ \mu$ final state, topological vertexing
- $\mu\ \mu$: time dependent analysis
- [depending on available manpower we could adjust the experimental goal, e.g. LFV]

Phenomenological side:

For LFV B decays few upper limits exist.

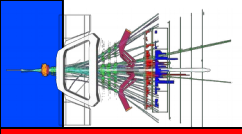
$BR(B_d \to K\ e(\mu)\ \tau) < 3.0(4.8) \times 10^{-5}$

$BR(B_d \to \pi\ e(\mu)\ \tau) < 2.0(7.2) \times 10^{-5}$

$BR(B_d \to \mu\tau) < 2.2 \times 10^{-5}$

- B_s to $\tau\ \mu$: Study motivation for measurement.

Classification of models in terms of LFU breaking and LFV signatures.
Study interplay between LFV B decays and with other channels, e.g. Higgs decays



The collaboration

Collaborative aspects of the project are numerous and already proven.

Already collaborating with the co-direction of Alessandro Mordà's OCEVU PhD thesis - 3rd year - (Jérôme & Giampiero) and with Andrey Tayduganov.
Many of the best variables used in Alessandro's BDT come from interaction with CPT.

The **skills** of the two involved teams are **complementary**

CPPM:

expertise on the measurement of rare decays at CPPM (first evidence for $B_s \to \mu\mu$ branching ratio, observation just published in Nature, and angular analysis of the $B \to K^*\mu\mu$ decay) – unique skills, isolations algos, MVAs, zvtop...

CPT

expertise on phenomenological data interpretation at CPT (the first basis for the theoretical calculation of heavy-to-light decays + rebuilding of the CKMfitter software)

Recent manpower : Kristof de Bruyn (CPPM, ANR 2 ans), Aoife Bharucha (CPT)

Masse critique necessary – as in $B_s \to \mu\mu$ (5 out of 18 principal authors from CPPM)
Other LHCb groups interested, Cagliari, LPHNE (+Imperial) → **visibility CPPM/CPT**