GPPU Progress Report
-- Lepton Flavor Universality Tests at Belle II --

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GP-PU Progress Status Presentation

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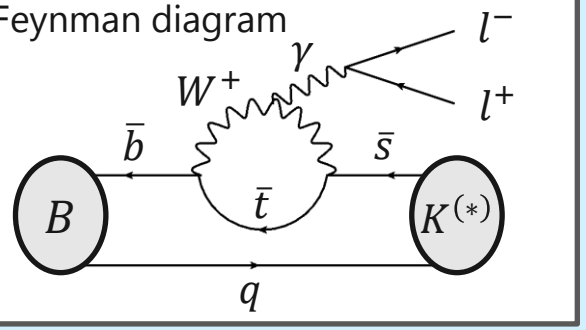
Background of the study

In the Standard Model of particle physics
e, μ, τ are identical, except for masses = **Lepton Flavor Universality (LFU)**

LFU tests in B meson decay

$$R_{K^{(*)}} \equiv \frac{\text{Prob.}\left[B \to K^{(*)}\,\mu^+\,\mu^-\right]}{\text{Prob.}\left[B \to K^{(*)}\,e^+\,e^-\right]}$$

Feynman diagram



SM expectation : $R_K \simeq R_{K^*} \simeq 1$

Latest results in LHCb :

$R_K = 0.846^{+0.060}_{-0.054}(\text{stat.})^{+0.016}_{-0.014}(\text{syst.})$,

$R_{K^*} = 0.69^{+0.11}_{-0.07}(\text{stat.}) \pm 0.05(\text{syst.})$

➔ **~2.5 σ discrepancy from SM**

e : **More** and/or μ : **Less**

If the LFU violation is discovered,

It is an evidence of new physics and must be the Novel Prize !!

Purpose of the study

Observables / Decay Particle ?	$\frac{\text{Prob.}(B \to ? \mu^+ \mu^-)}{\text{Prob.}(B \to ? e^+ e^-)}$ ***Test LFU***	Prob.$(B \to ? \mu^+ \mu^-)$ & Prob.$(B \to ? e^+ e^-)$ ***Determine a model***
K , K^*	Accuracy : High	Theoretical error : 20-50% → Accuracy : Low
X_s K K π … K^* K π π	Accuracy : High	Theoretical error : ~10% → **Accuracy : High**

LHCb：Difficult to detect neutral particles → *Impossible to study* X_s

Belle II：Possible to detect charged and neutral particles precisely

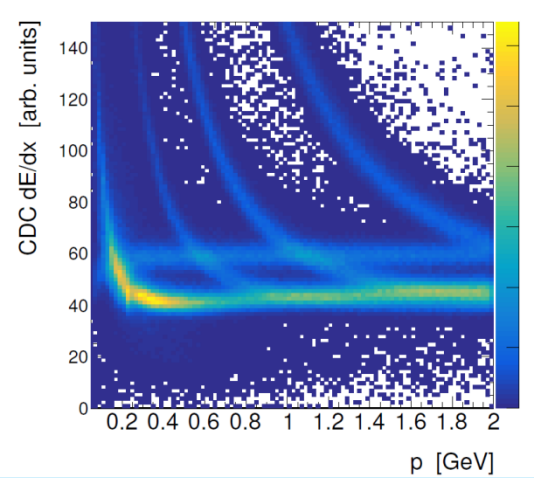
Test LFU and Determine a new physics model with X_s mode

Systematic study of Lepton ID

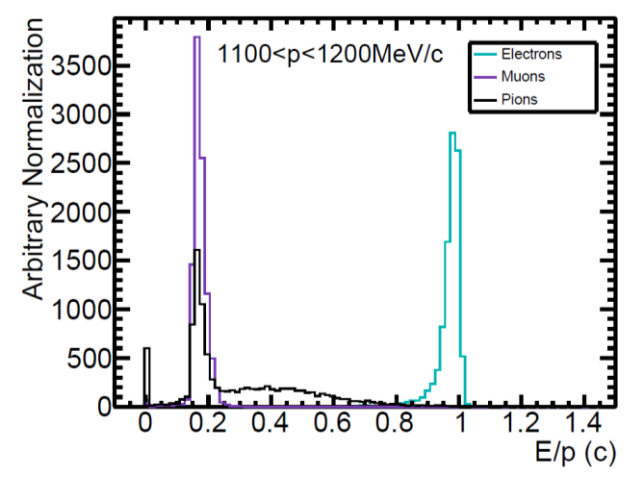
Particle Identification (ID) :

Process to identify the type of particle using detector information.

(e.g.)



dE/dx in the Belle II tracker (CDC)



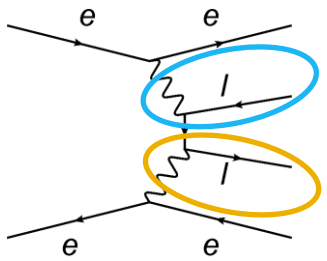
Energy deposit in calorimeter over momenta of track

Lepton ID is a dominant source of systematic uncertainty of my research.

→ We have to study the efficiency and its uncertainty of the lepton ID.

Systematic study of Lepton ID

- Use two-photon event with **tag&probe** method to get pure leptons.



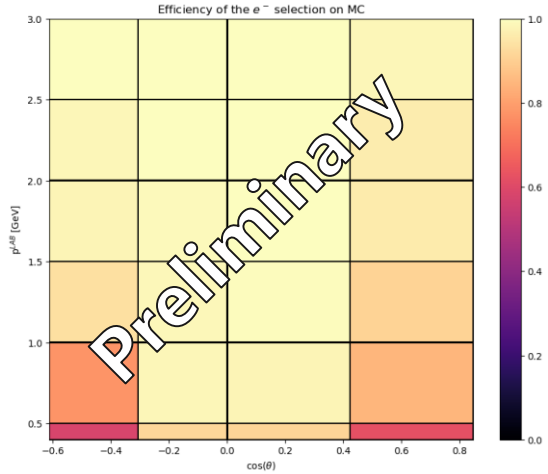
tag a lepton

use the other lepton as a probe

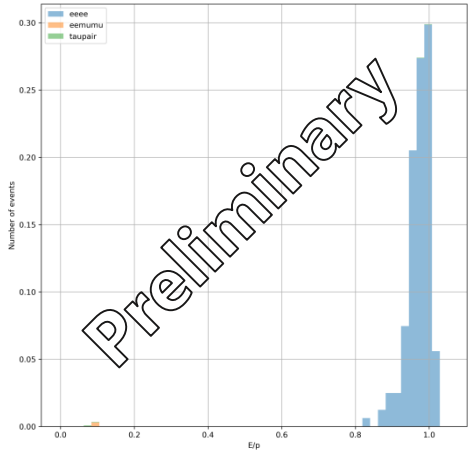
- Main background is $ee \to \tau\tau$ event.
  Optimized selection criteria to suppress the background contribution.

- Built a framework of systematic study of lepton ID with DESY colleagues.
  We have presented results of electron ID at collaboration meeting.

(e.g.)



Electron ID efficiency of MC study as function of P and $\cos\theta$.

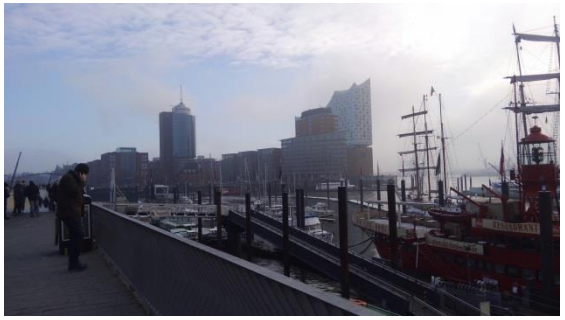


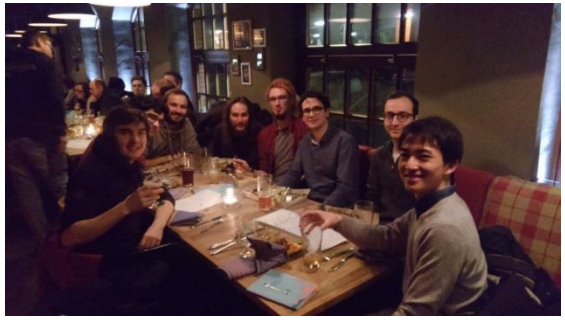
E/P distribution of MC study in a bin.

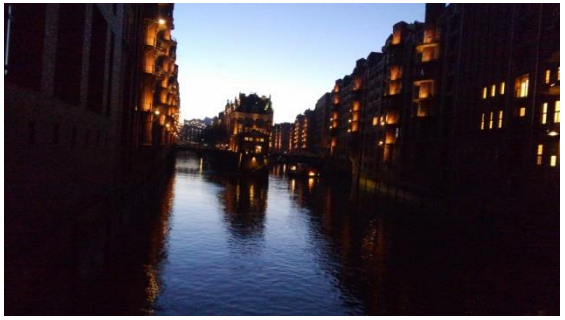
GPPU activity

- Research trip

- DESY (Hamburg, Germany), 1 month (2019/1/8 – 2019/2/2)
  - Purpose : To develop the framework of lepton ID.
    DESY colleagues are main contributors of software development.
  - I have also enjoyed food, beer and sightseeing in Hamburg!







GPPU activity

- GPPU points (if I remember correctly)
  - GSP : 20 points (GASP: 1 point)
  - GEP : 14 points + 6 points (ongoing, N3)

Future plan

- Systematic study of lepton ID using new data.
- Background study for the $B \rightarrow X_s\, l^+\, l^-$ process in MC simulation.
- Research trip to DESY again. (2019/5/15 – 2019/6/15, Next week!)
  - Purpose : To develop a software tool for the background study