



CEPC Flavor Physics Discussion - II

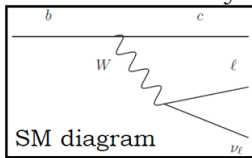
Manqi Ruan

Multiple physics benchmarks proposed

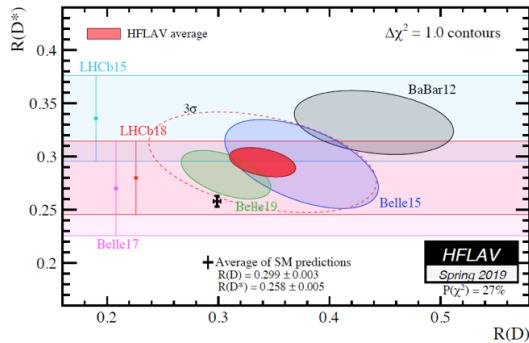
Class I.

$$R_{D^{(*)}} \equiv \frac{\text{BR}(B \rightarrow D^{(*)} \tau \nu)}{\text{BR}(B \rightarrow D^{(*)} \ell \nu)}, \quad \ell = e, \mu$$

Test of the Lepton Flavour Universality of SM couplings →



$\approx 3\sigma$
from the SM



requires a 15-20% enhancement wrt the SM

Class II.

$$R_{K^{(*)}} \equiv \frac{\text{BR}(B \rightarrow K^{(*)} \mu^+ \mu^-)}{\text{BR}(B \rightarrow K^{(*)} e^+ e^-)}$$

= 1 ± 0.01 in the SM: lepton flavour universality

Bordone et al. '16

LHCb measurements ($1.1 \text{ GeV}^2 < q^2 < 6 \text{ GeV}^2$):

$$R_K = 0.846_{-0.054}^{+0.060} \pm 0.016$$

LHCb '19

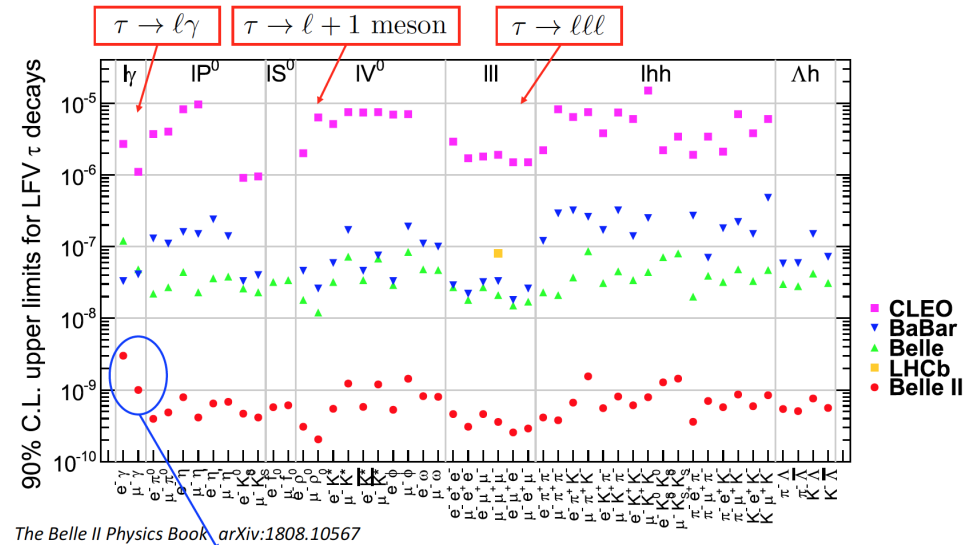
$$R_{K^*} = 0.685_{-0.069}^{+0.113} \pm 0.047 \approx 2.5\sigma \text{ off}$$

LHCb '17

Few sigma discrepancies in other obs with larger hadronic uncertainties:

Angular observables in
 $B \rightarrow K^* \mu^+ \mu^-$

Some $b \rightarrow s \mu^+ \mu^-$ BRs



Radiative modes affected by ISR photon background:
Expected sensitivity too optimistic?

Z exotic LFV decays...

Performance/simulation study starts

Activities since

- Benchmark analysis on physics

- Higgs:

- H->di muon/di photon
 - H->multi jets

Hope some result will be mature enough,
To discussed at the Nov/Hongkong WS

- Flavor:

- Bc->tau nu
 - Tau exotic decay
 - Bc->J/psiPhi

- EW: TGC

- Performance

- Fast simulation & PFA oriented detector optimization

- Jet lepton id performance: degrading w.r.t separation & clustering performance

A strong motivation to review the detector requirement

128 EXPERIMENTAL CONDITIONS, PHYSICS REQUIREMENTS AND DETECTOR CONCEPTS

Physics process	Measurands	Detector subsystem	Performance requirement
$ZH, Z \rightarrow e^+e^-, \mu^+\mu^-$ $H \rightarrow \mu^+\mu^-$	$m_H, \sigma(ZH)$ $\text{BR}(H \rightarrow \mu^+\mu^-)$	Tracker	$\Delta(1/p_T) =$ $2 \times 10^{-5} \oplus \frac{0.001}{p(\text{GeV}) \sin^{3/2} \theta}$
$H \rightarrow b\bar{b}/c\bar{c}/gg$	$\text{BR}(H \rightarrow b\bar{b}/c\bar{c}/gg)$	Vertex	$\sigma_{r\phi} =$ $5 \oplus \frac{10}{p(\text{GeV}) \times \sin^{3/2} \theta} (\mu\text{m})$
$H \rightarrow q\bar{q}, WW^*, ZZ^*$	$\text{BR}(H \rightarrow q\bar{q}, WW^*, ZZ^*)$	ECAL HCAL	$\sigma_E^{\text{jet}}/E =$ $3 \sim 4\% \text{ at } 100 \text{ GeV}$
$H \rightarrow \gamma\gamma$	$\text{BR}(H \rightarrow \gamma\gamma)$	ECAL	$\Delta E/E =$ $\frac{0.20}{\sqrt{E(\text{GeV})}} \oplus 0.01$

Table 3.3: Physics processes and key observables used as benchmarks for setting the requirements and the optimization of the CEPC detector.

The Tracking resolution is considered to be difficult to realize – especially in the context Of realistic material budget/cooling

The ECAL resolution may potentially be improved, by using Crystal...

It is critical to identify Flavor Benchmarks, that benefit from good tracking/ECAL, and has Important physics motivation

One of the obvious benchmark

Tau LFV prospects

- $\tau \rightarrow \ell\ell\ell$: background-free at the B-factories (with $4\text{-}7 \times 10^8$ tau pairs)

If this is the case (?), CEPC can give (3×10^{10} pairs and search effic. $\approx 10\%$):

$$\text{BR}(\tau \rightarrow \ell\ell\ell) \lesssim 4 \times 10^{-10}$$

(Q: is it really background free at Tera-Z?)

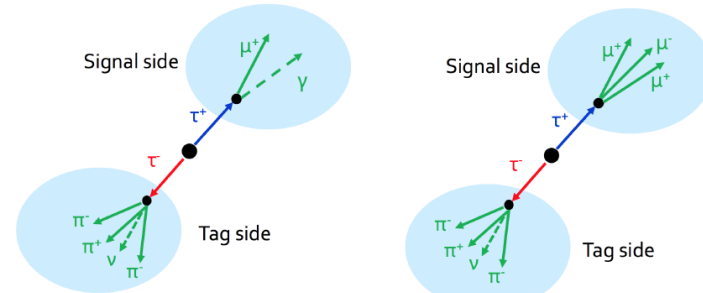
- $\tau \rightarrow \ell\gamma$: limited by radiative events bg (leptonic tau decays + ISR or FSR γ)
Simulation performed for FCC-ee.

M. Dam @ Tau '18 & 1811.09408

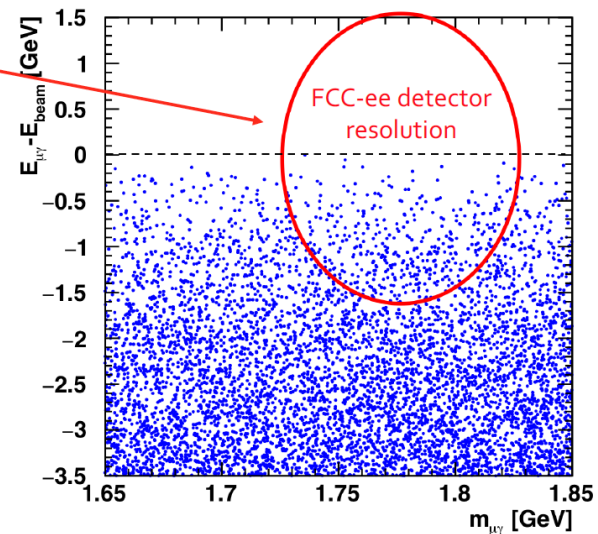
Rescaling by the CEPC number of taus:

$$\text{BR}(\tau \rightarrow \ell\gamma) \lesssim 3 \times 10^{-9}$$

(again at the level of Belle II expectation)



Comparable to Belle II reach



Coming meetings

- November CEPC WS
 - (Nov 18 – 20) <https://indico.ihep.ac.cn/event/9960/>
 - A dedicated discussion on physics requirement would be organized at 21st, Thursday
- Hongkong IAS working month
 - 2020.1.16 - 17, detector WS: discuss the physics requirement & software
 - 2020.1.18 - 19, CEPC Physics WS: discuss the CEPC physics report & physics benchmark channels
 - 2020.1.20 - 22, Conference