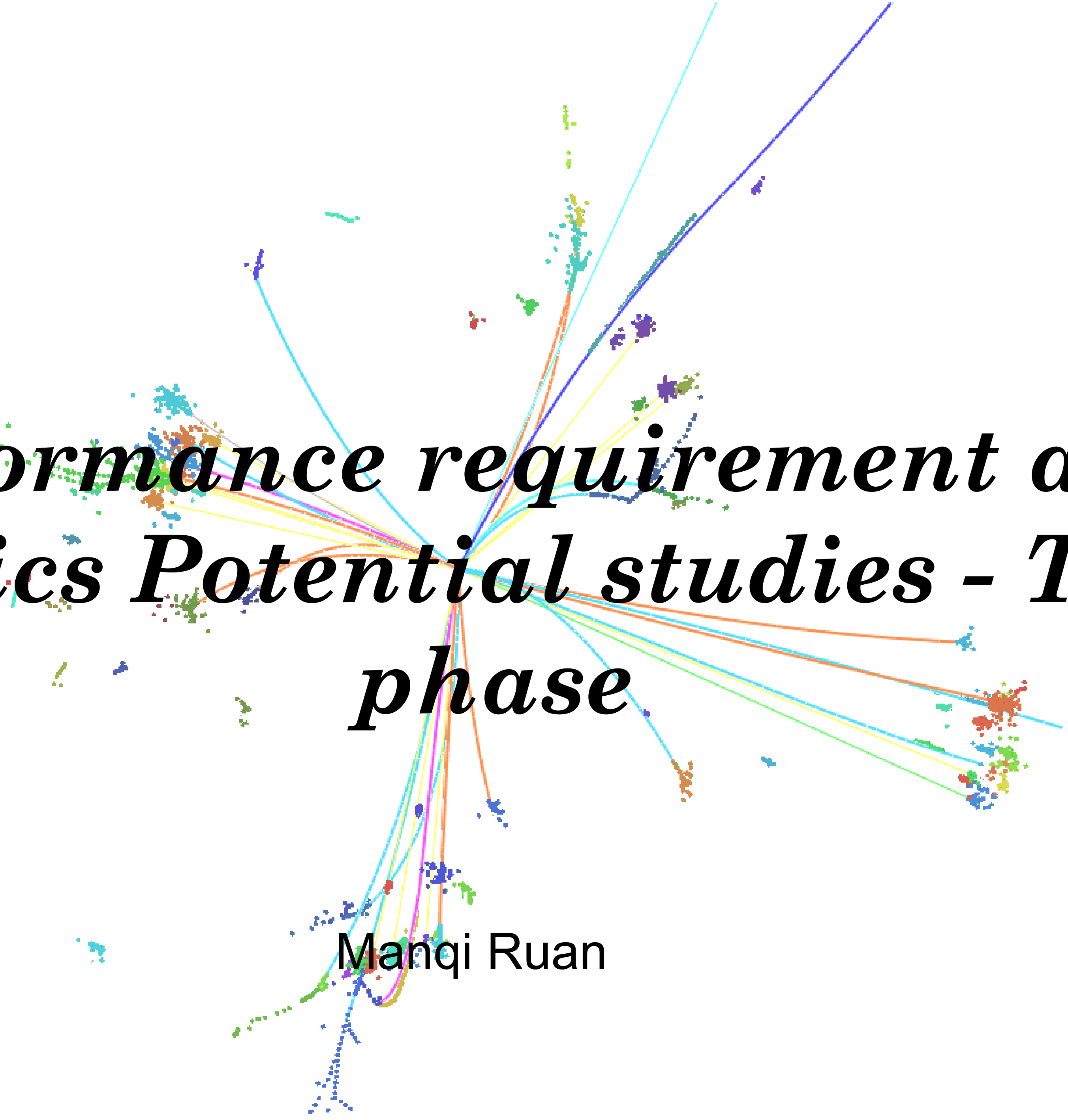
Performance requirement and Physics Potential studies - TDR phase



Manqi Ruan

background

- The CEPC CDR clearly quantifies the physics potential in Higgs via full simulation

- The physics potential in EW, Flavor, and QCD can be better quantified – especially under the context that a trillion clean Z event will be recorded

- Those measurements will make requirement on the detector performance: emphasize more on particle identification, intrinsic sub-detector resolution (momentum and energy), and on particle separation...

The cepc cdr detectors

- Baseline - Fulfills the physics requirement on Higgs/EW measurement, but
  - Ideal & difficult to construct in its tracking
  - Massive in its calorimeter readout/cooling
  - Has limited ECAL intrinsic resolution

- Need also be addressed in the TDR studies

- Huge interests in general software framework develooment

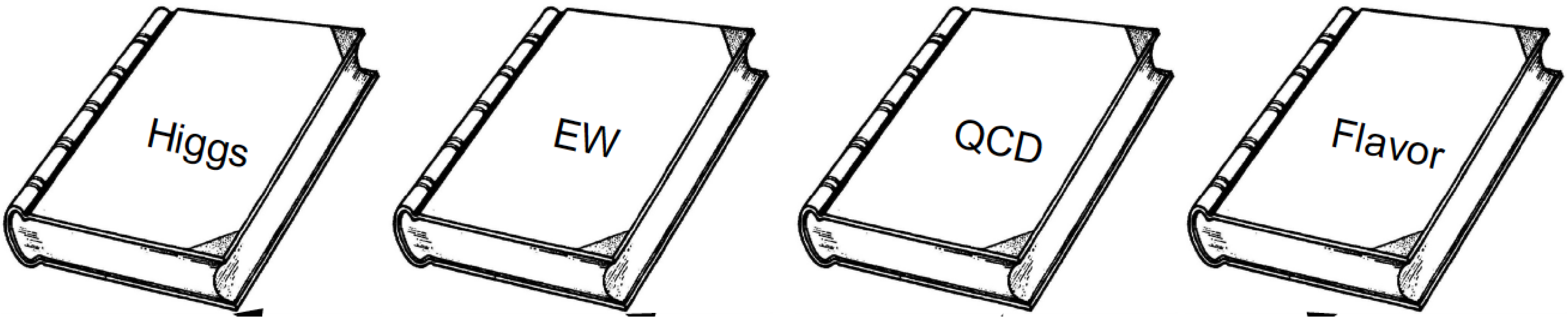
Coming Hongkong WSs

- Many thanks to Hongkong IAS: providing us a nice occasion to discuss those questions

- 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

Recent Highlight – white paper preparation



- To promote the physics study at TDR & to converge to the Physics White Papers by the end of 2020
- Physics white papers:
  - Physics handbooks for new comers: PostDoc/Student
  - Official references for the physics potential
  - Guideline for future detector design/optimization

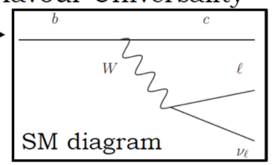
75 registrant + several visitors; ~ 50 talks. Covers Physics, Pheno, and Performance studies
Multiple Benchmarks are proposed, related performance/analysis are presented
Supported by IHEP CFHEP & PKU

Multiple physics benchmarks proposed

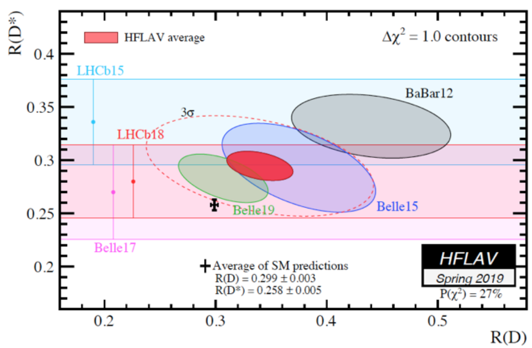
Class I.

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

Test of the Lepton Flavour Universality of SM couplings →



$\approx 3\sigma$ from the SM

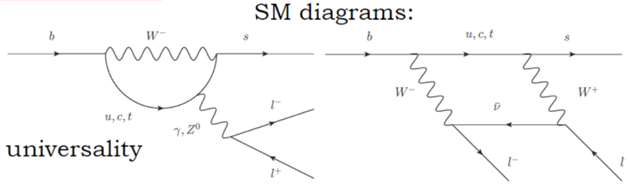


requires a 15-20% enhancement wrt the SM

Class II.

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

SM diagrams:



=1+-0.01 in the SM: lepton flavour universality
Bordone et al. '16

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

$R_K = 0.846\,^{+0.060}_{-0.054}\,^{+0.016}_{-0.014}$, LHCb '19

$R_{K^*} = 0.685^{+0.113}_{-0.069} \pm 0.047$ LHCb '17

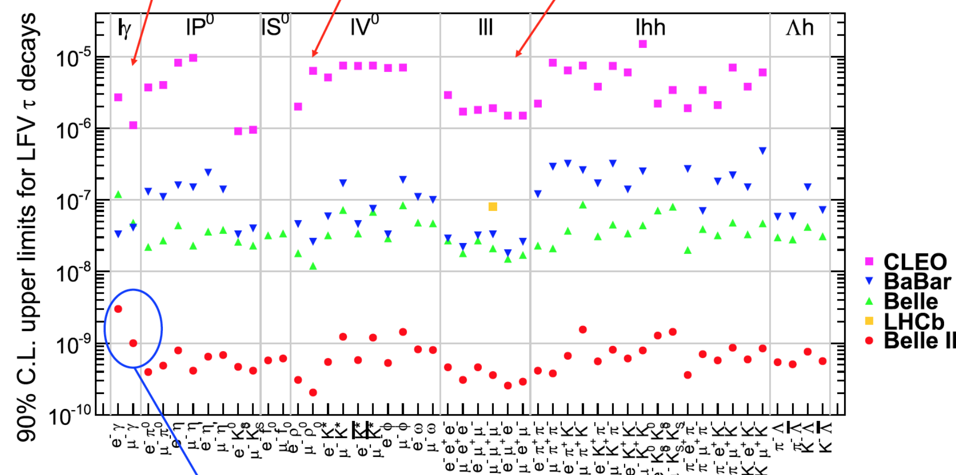
$\approx 2.5\sigma$ off

Few sigma discrepancies in other obs with larger hadronic uncertainties:

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

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

$\tau \to \ell\gamma$ $\tau \to \ell + 1$ meson $\tau \to \ell\ell\ell$



The Belle II Physics Book arXiv:1808.10567

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
  - Flavor:
    - Bc->tau nu
    - Tau exotic decay
  - EW: TGC
- Performance
  - Fast simulation & PFA oriented detector optimization
  - Jet lepton id performance
  -

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

backup

CEPC Flavor Physics

70 OVERVIEW OF THE PHYSICS CASE FOR CEPC

Particle	Tera-Z	Belle II	LHCb
b hadrons			
B^+	6×10^{10}	3×10^{10} ($50\,\text{ab}^{-1}$ on $\Upsilon(4S)$)	3×10^{13}
B^0	6×10^{10}	3×10^{10} ($50\,\text{ab}^{-1}$ on $\Upsilon(4S)$)	3×10^{13}
B_s	2×10^{10}	3×10^{8} ($5\,\text{ab}^{-1}$ on $\Upsilon(5S)$)	8×10^{12}
b baryons	1×10^{10}		1×10^{13}
Λ_b	1×10^{10}		1×10^{13}
c hadrons			
D^0	2×10^{11}		
D^+	6×10^{10}		
D_s^+	3×10^{10}		
Λ_c^+	2×10^{10}		
τ^+	3×10^{10}	5×10^{10} ($50\,\text{ab}^{-1}$ on $\Upsilon(4S)$)	

Table 2.4: Collection of expected number of particles produced at a tera-Z factory from 10^{12} Z-boson decays. We have used the hadronization fractions (neglecting p_T dependencies) from Refs. [431, 432] (see also Ref. [433]). For the decays relevant to this study we also show the corresponding number of particles produced by the full $50\,\text{ab}^{-1}$ on $\Upsilon(4S)$ and $5\,\text{ab}^{-1}$ on $\Upsilon(5S)$ runs at Belle II [430], as well as the numbers of b hadrons at LHCb with $50\,\text{fb}^{-1}$ (using the number of $b\bar{b}$ pairs within the LHCb detector acceptance from [435] and the hadronization fractions from [431]).

Comparative advantages

vs LHCb:
- Reconstruction of neutral particles
- Reconstruction of jet charge
- ...

vs Belle II:
- Higher Boost
- Large phase space

Challenges:
- Finding the decay products in Jets! (similar to LHCb)...