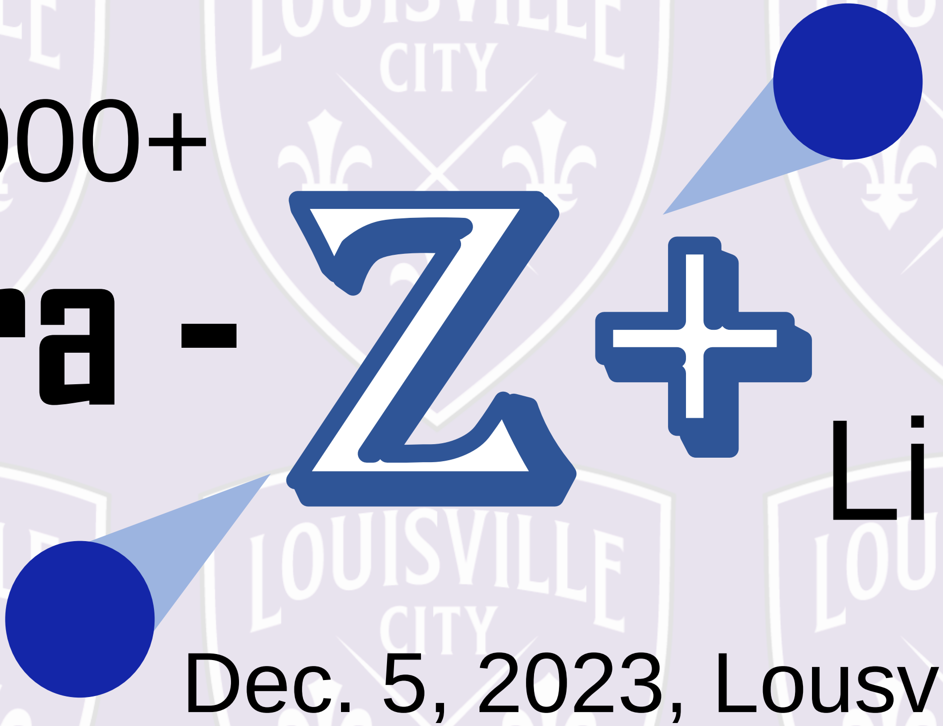
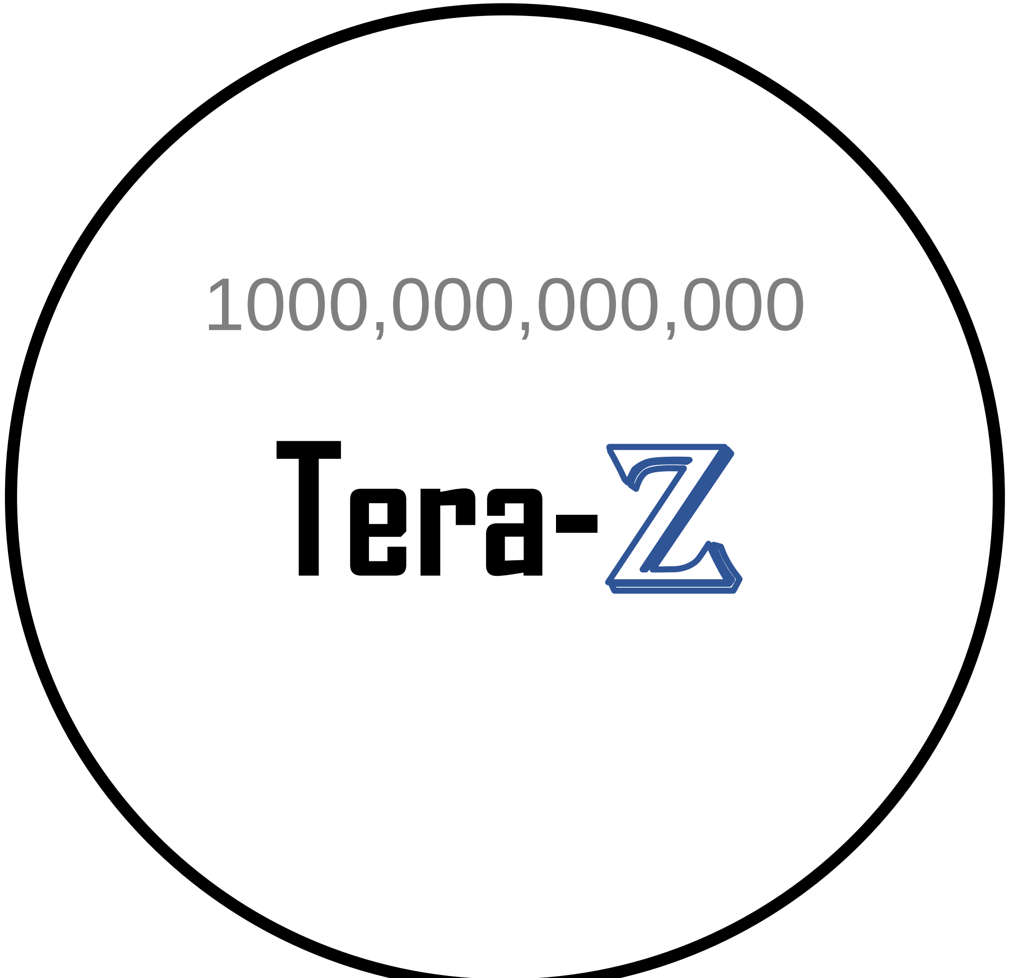
Tau-LFUV Tests

4000,000,000,000+ At A Tera - Z+

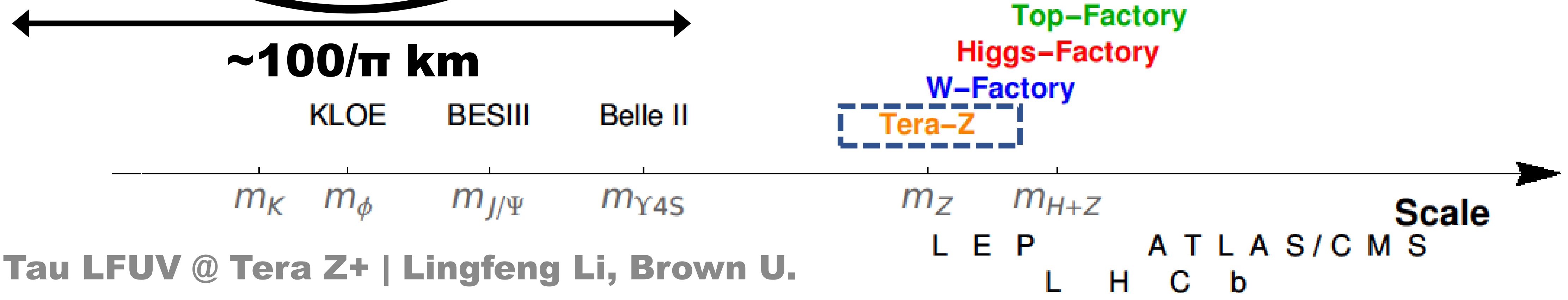


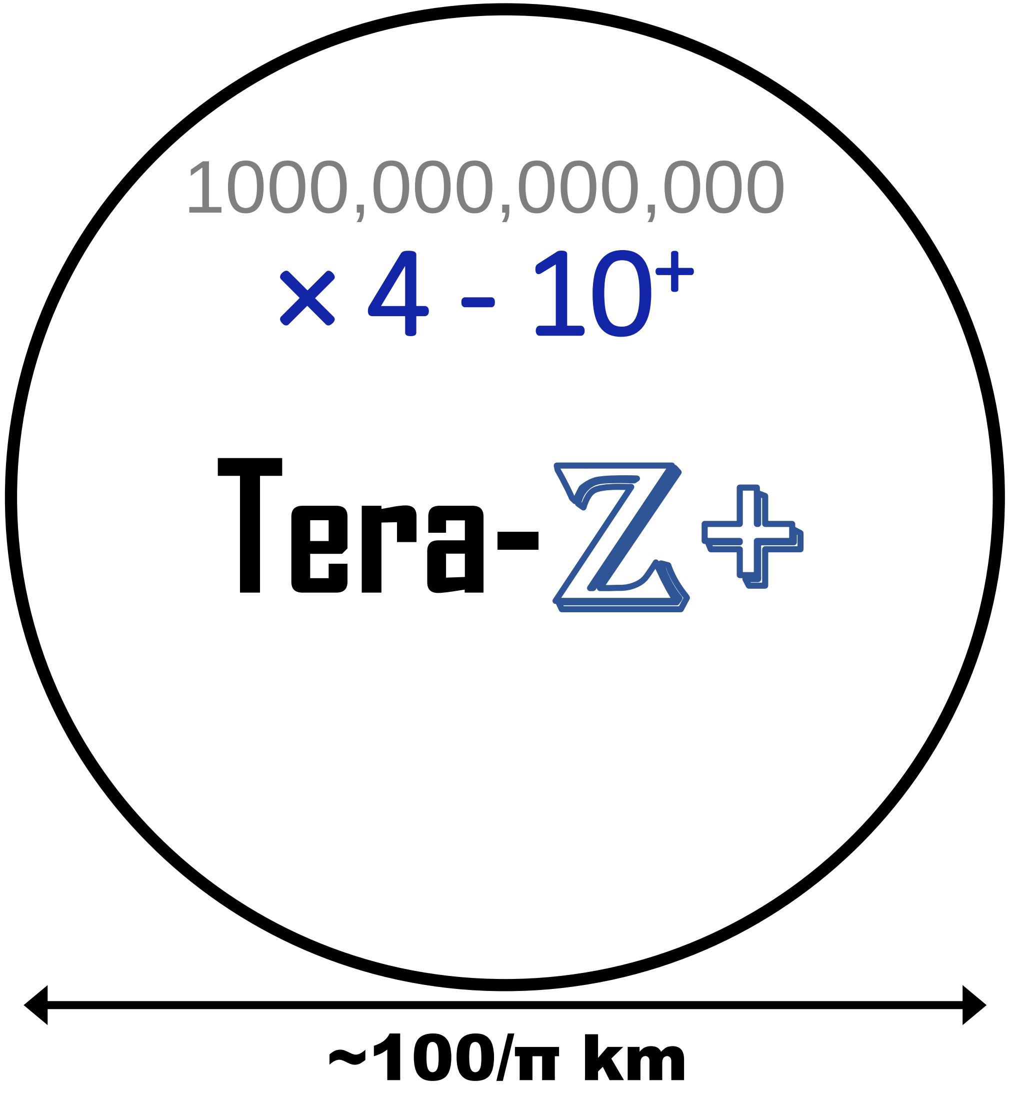
Lingfeng Li
Brown University

Dec. 5, 2023, Lousville, τ2023



- Clean lepton collider (good for ν, γ, τ, e …) Big advantages vs. hadronic ones
- O(10^{11+}) b/c/τ (> B-factory of 50 ab^{-1})
- Generates all kinds of hadrons (B_c, Λ_b, T_{bb}…)
- Large energy (20-45 GeV) and boost for precision measurements
- Most advanced tech. infused detectors




1000,000,000,000

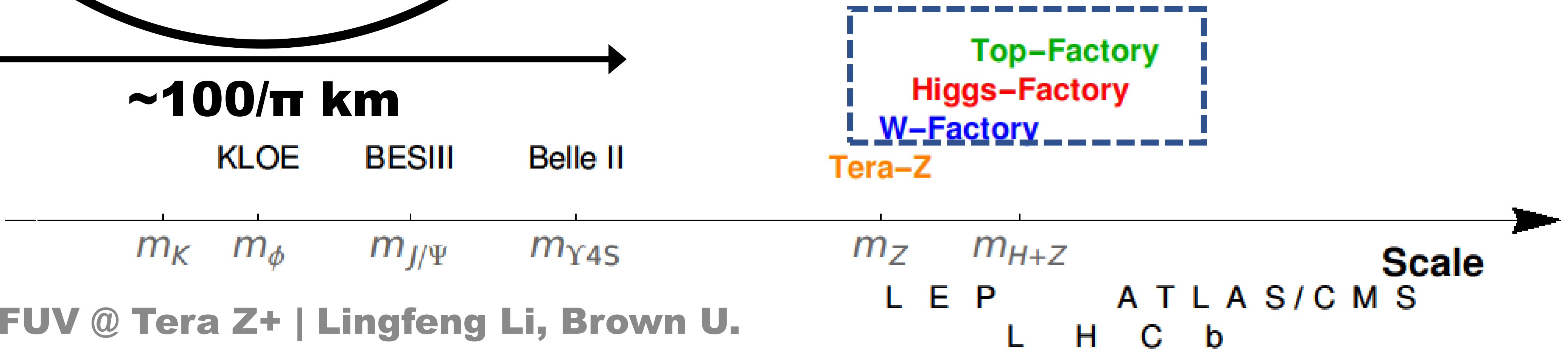
$\times 4 - 10^{+}$

Tera-Z+

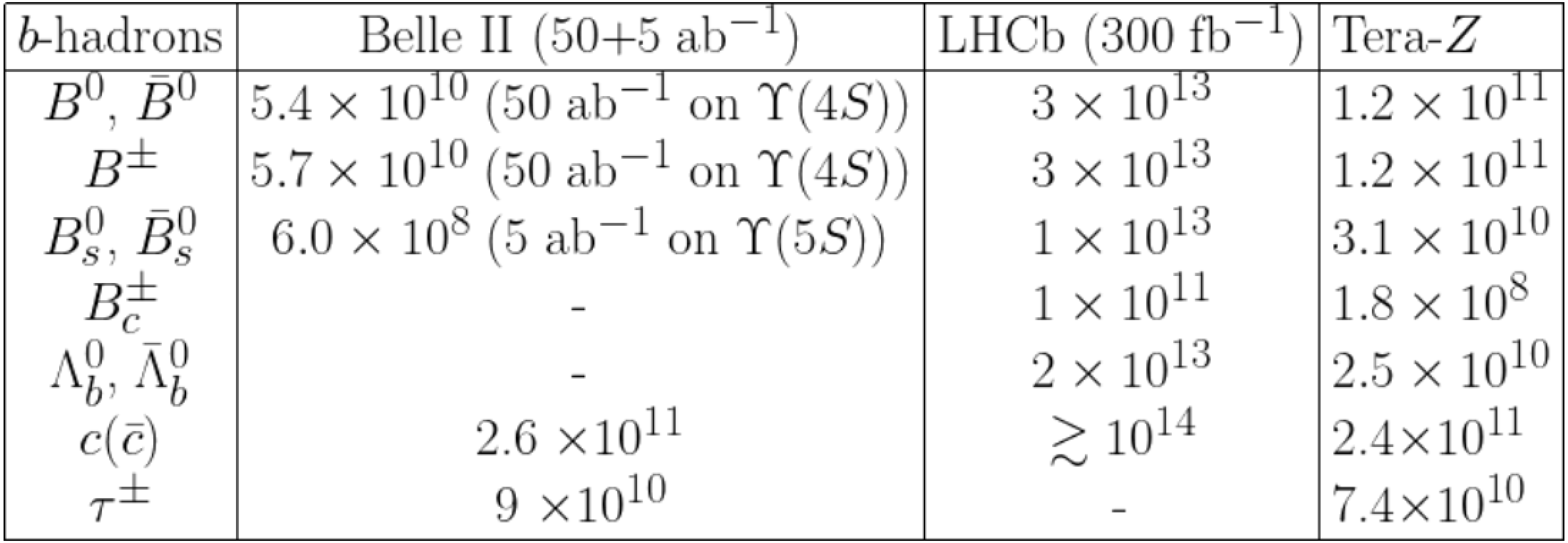
~100/π km

- ➢ Higher luminosity as the accelerator design keeps evolving
- ➢ ≥ 2 interaction points and various detectors

Flavor physics also need energy larger than 91 GeV (e.g., $|V_{cb}|$ from W decays)



Tera-Z+ as a Flavor Factory

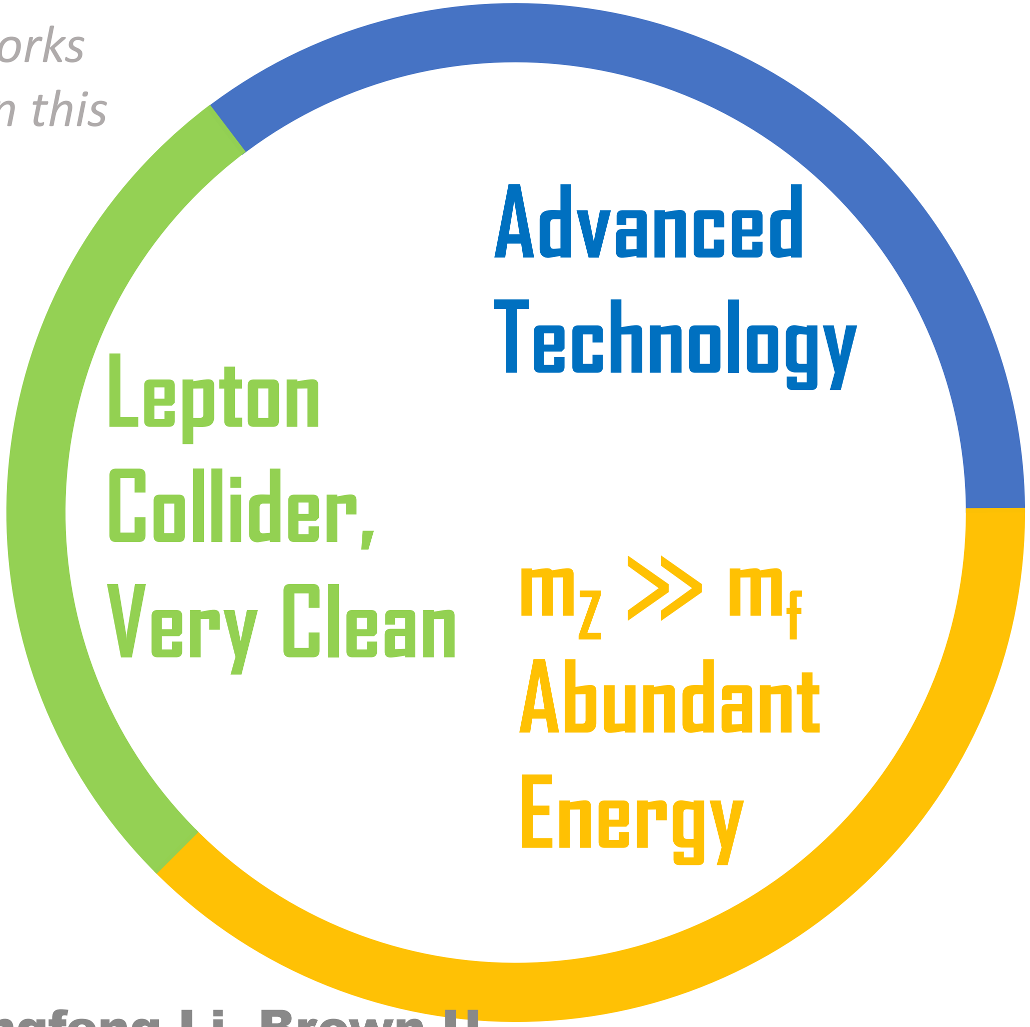


b-hadrons	Belle II (50+5 ab^{-1})	LHCb (300 fb^{-1})	Tera-Z
B^0, $\bar{B}^0$	5.4×10^{10} (50 ab^{-1} on $\Upsilon(4S)$)	3×10^{13}	1.2×10^{11}
$B^\pm$	5.7×10^{10} (50 ab^{-1} on $\Upsilon(4S)$)	3×10^{13}	1.2×10^{11}
B_s^0, $\bar{B}_s^0$	6.0×10^{8} (5 ab^{-1} on $\Upsilon(5S)$)	1×10^{13}	3.1×10^{10}
$B_c^\pm$	-	1×10^{11}	1.8×10^{8}
Λ_b^0, $\bar{\Lambda}_b^0$	-	2×10^{13}	2.5×10^{10}
$c(\bar{c})$	2.6×10^{11}	$\gtrsim 10^{14}$	2.4×10^{11}
$\tau^\pm$	9×10^{10}	-	7.4×10^{10}

Z Factory and LFUV Tests with Tau

Disclamer: will focus on experimental uncertainties/works rather than theoretical ones in this talk

- ☐ Neutrinos
- ☐ Neutrals ($\text{photon}/\pi^0/\eta$…)
- ☐ Rare modes
- ☐ BSM states ✓



Lepton Collider, Very Clean

Advanced Technology

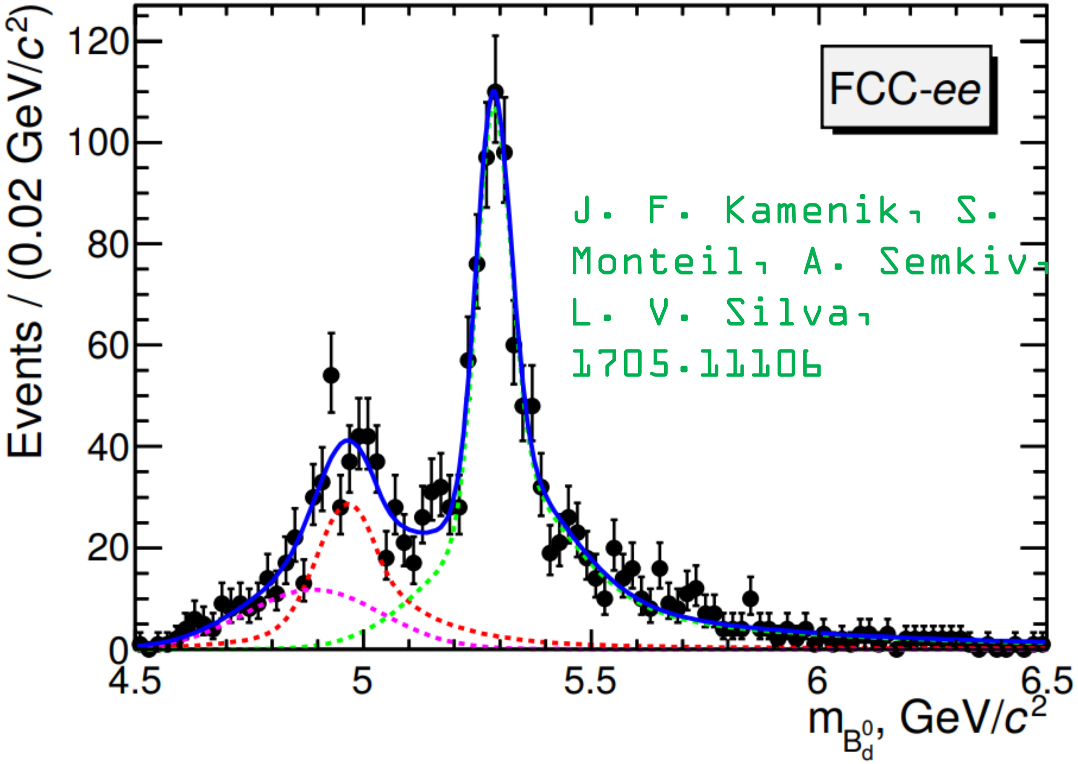
$m_Z \gg m_f$ Abundant Energy

- ☐ Leptons ✓
- ☐ Flavor Tagging
- ☐ b→c →τ cascade ✓
- ☐ Long-lived particles

- ☐ Boost: O(fs) time scales
- ☐ Heavy Species: B_s, B_c, Λ_b, exotics… ✓
- ☐ Multiple soft tracks ✓

FCNC Dileptonic Transitions

- ➢ Rare decays, sensitive to BSM
- ➢ Partially motivated by R_K and R_{K*} anomalies
- ➢ Flagship mode: $b \to s\tau\tau$, highly sensitive to LFUV in 3rd generation



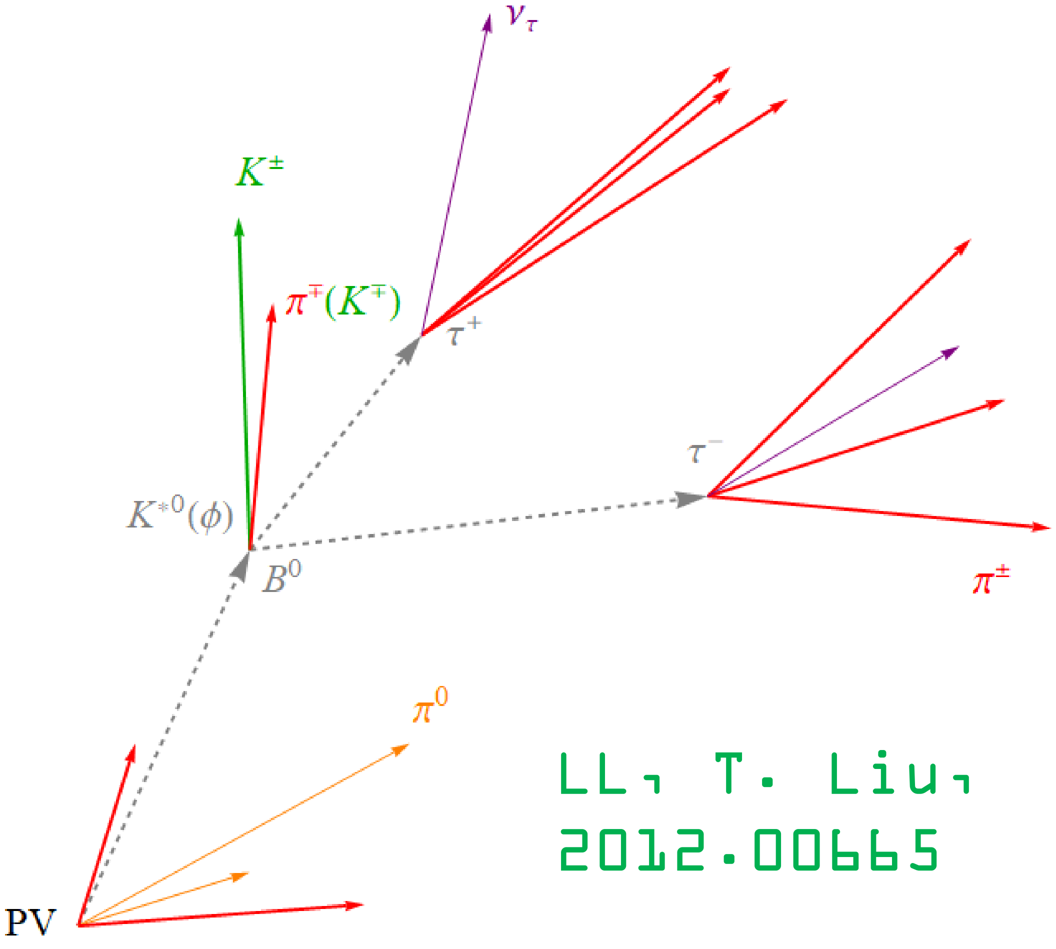
J. F. Kamenik, S. Monteil, A. Semkiv, L. V. Silva, 1705.11106

*Known to be difficult at other machines

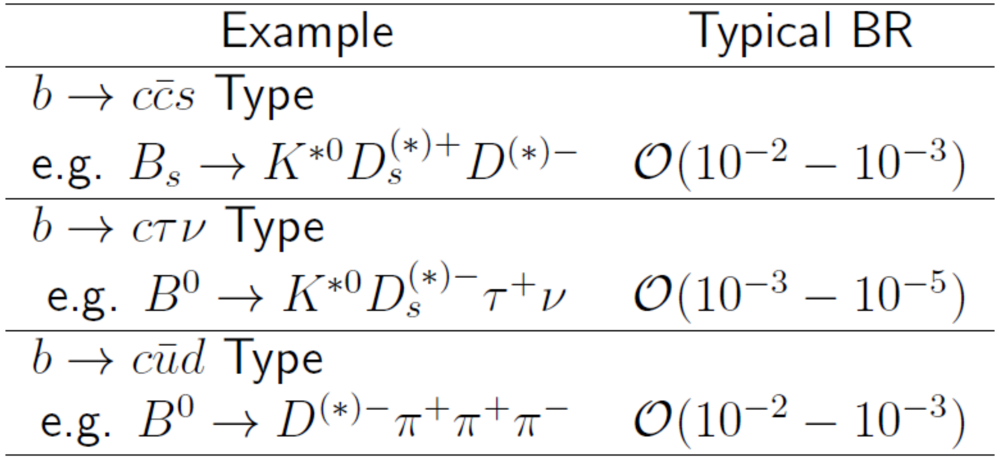
- ❖ At B factories: soft tracks, low boost for displacement
- ❖ At hadron colliders: Low acceptance, large flavored background, lacking neutrino modes

Current expected precision > $O(10^{-5})$

Phenomenology



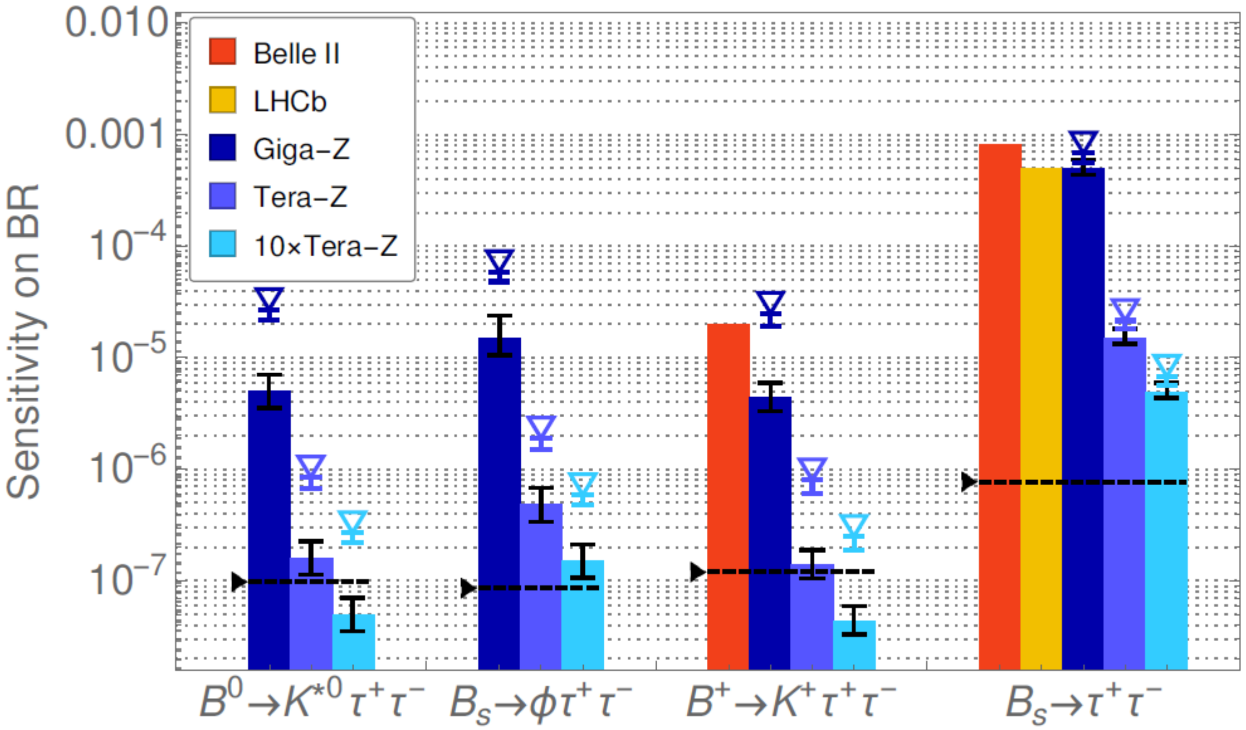
LL, T. Liu,
2012.00665

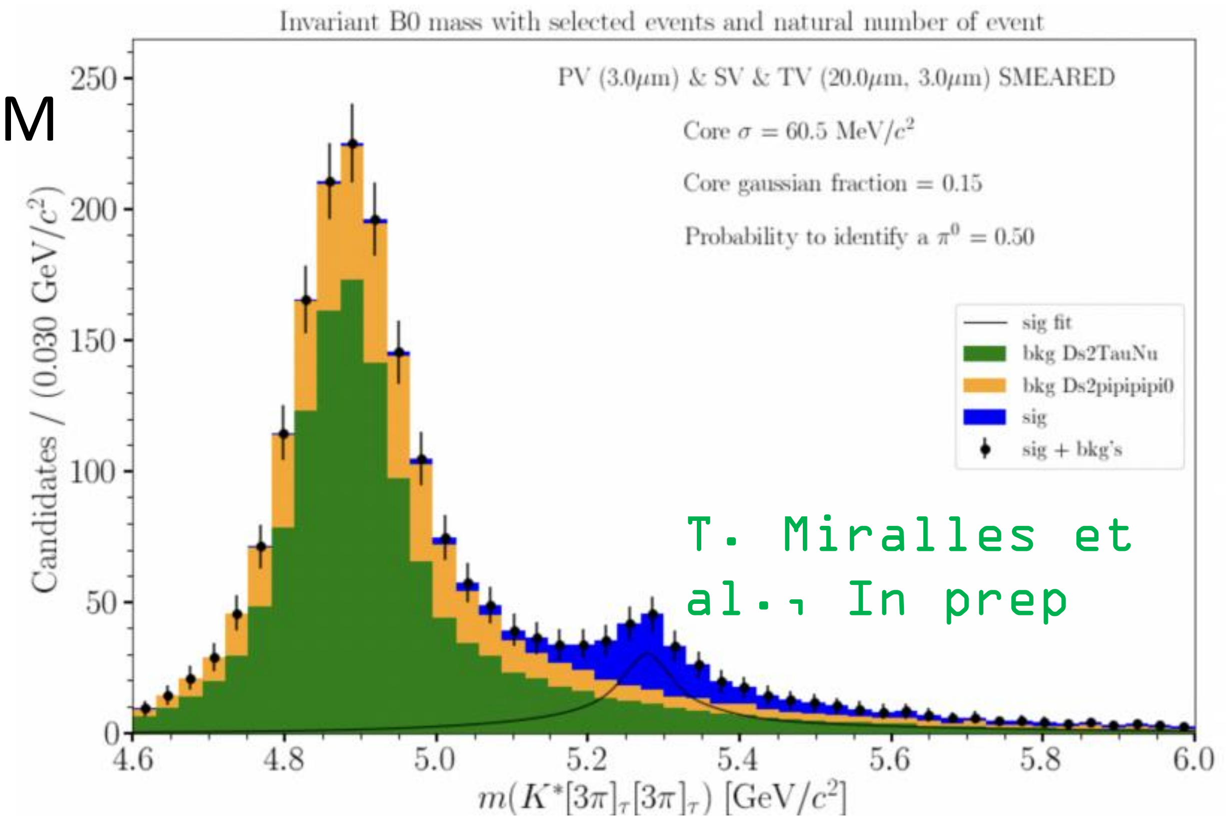
- Reconstruction from track momenta, on-shell condition and vertex displacements
- In reality, non-zero backgrounds mainly from hadronic $D_{(s)}$ mesons with their decays to 3π+X
- 

Example	Typical BR
$b \to c\bar{c}s$ Type	
e.g. $B_s \to K^{*0} D_s^{(*)+} D^{(*)-}$	$\mathcal{O}(10^{-2} - 10^{-3})$
$b \to c\tau\nu$ Type	
e.g. $B^0 \to K^{*0} D_s^{(*)-} \tau^+ \nu$	$\mathcal{O}(10^{-3} - 10^{-5})$
$b \to c\bar{u}d$ Type	
e.g. $B^0 \to D^{(*)-} \pi^+ \pi^+ \pi^-$	$\mathcal{O}(10^{-2} - 10^{-3})$

- Background reduction from multiple dimensions: isolation/resonance structure…

- Track/vertex impact parameter resolutions are most crucial to measurement
- If controlled to be < 10 µm, can probe the SM and validate significant deviations





T. Miralles et al., In prep

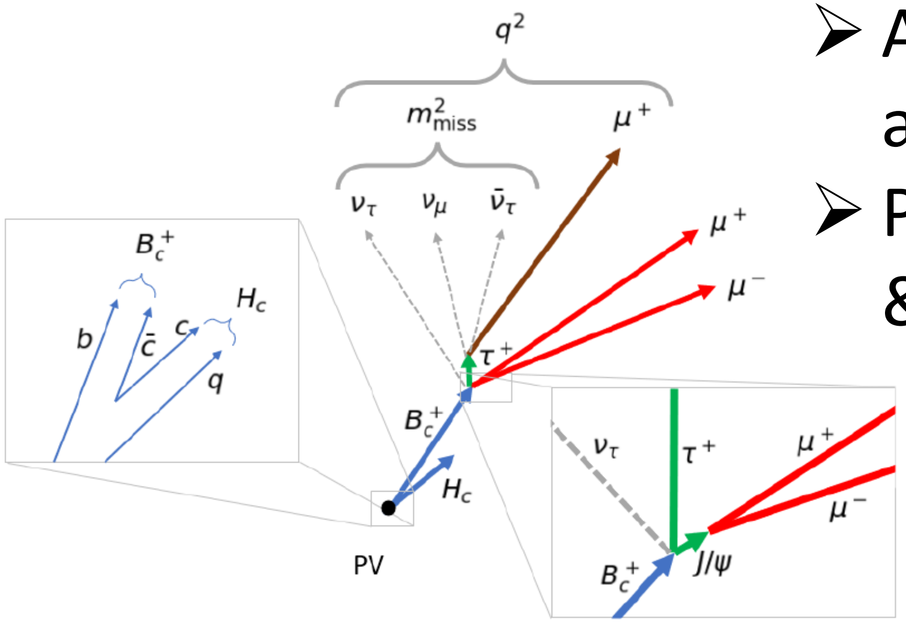
- Even better background mitigation by π^0 reconstruction from background D_s decays

Charged Current Transitions

$$R_{J/\psi} = \frac{\mathrm{Br}(B_c \to J/\psi\tau\nu)}{\mathrm{Br}(B_c \to J/\psi\mu\nu)}$$

$$R_{D_s^{(*)}} = \frac{\mathrm{Br}(B_s \to D_s^{(*)}\tau\nu)}{\mathrm{Br}(B_s \to D_s^{(*)}\mu\nu)}$$

$$R_{\Lambda_c} = \frac{\mathrm{Br}(\Lambda_b \to \Lambda_c\tau\nu)}{\mathrm{Br}(\Lambda_b \to \Lambda_c\mu\nu)}$$



- ➢ Anomalies also, still alive (?)
- ➢ Potential for $|V_{cb}|$ & $|V_{ub}|$ extraction

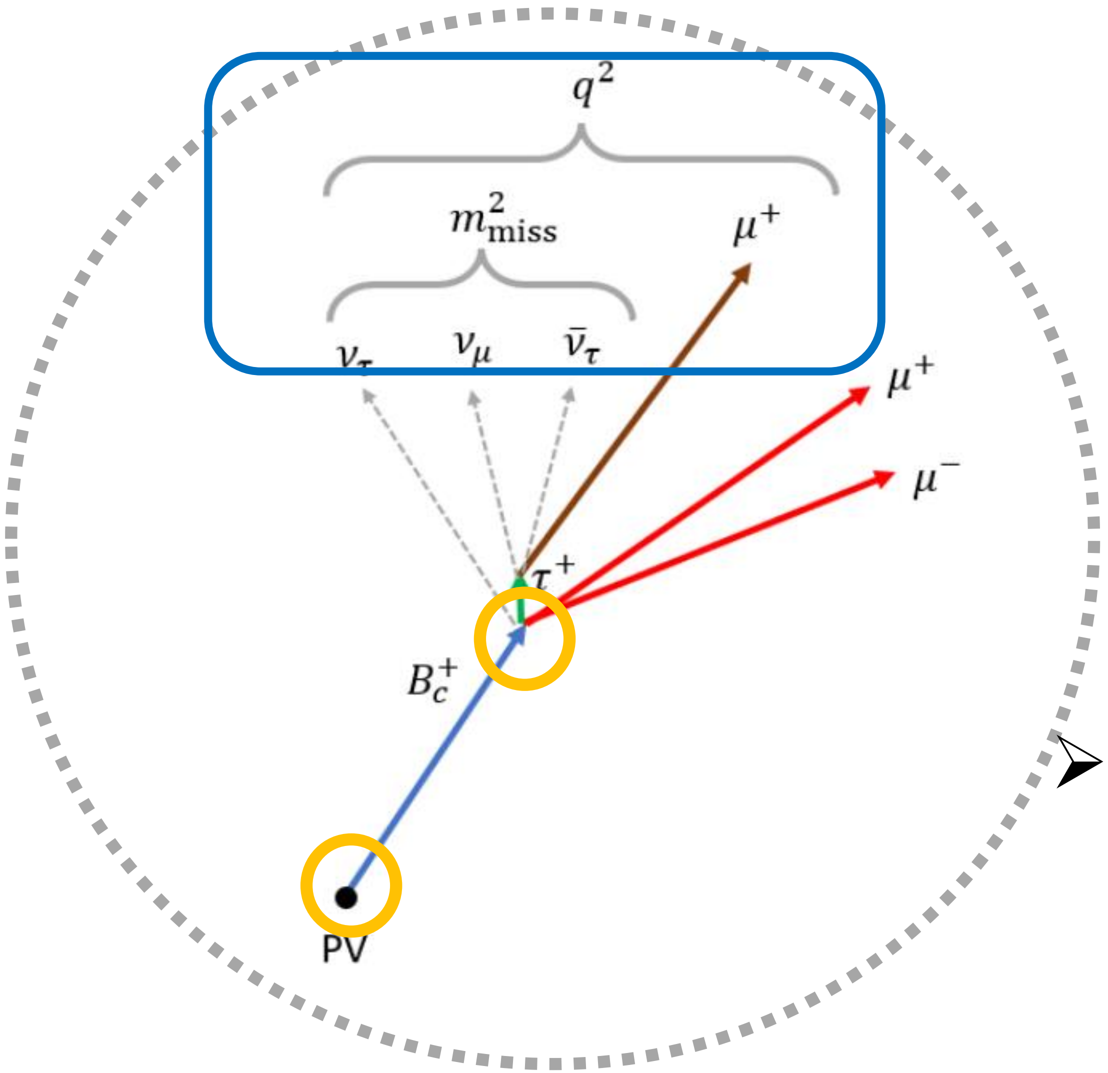
T.S.M. Ho, X.H. Jiang, T.H. Kwok, LL, T. Liu, 2210.10751

$$\mathrm{Br}(B_c \to \tau\nu)$$

T. Zheng, J. Xu, L. Cao, D. Yu, W. Wang, S. Prell, Y.K.E. Cheung, M. Ruan, 2007.08234;

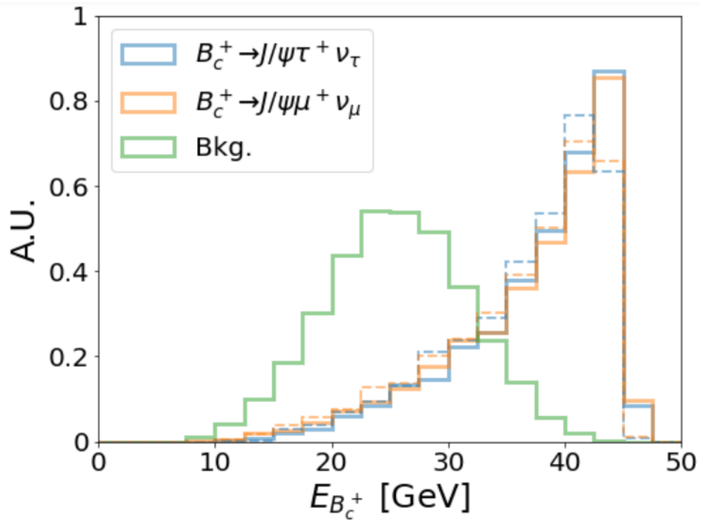
M. Fedele, C. Helsens, D. Hill, S. Iguro, M. Klute and X. Zuo, 2305.02998

Event Reconstruction



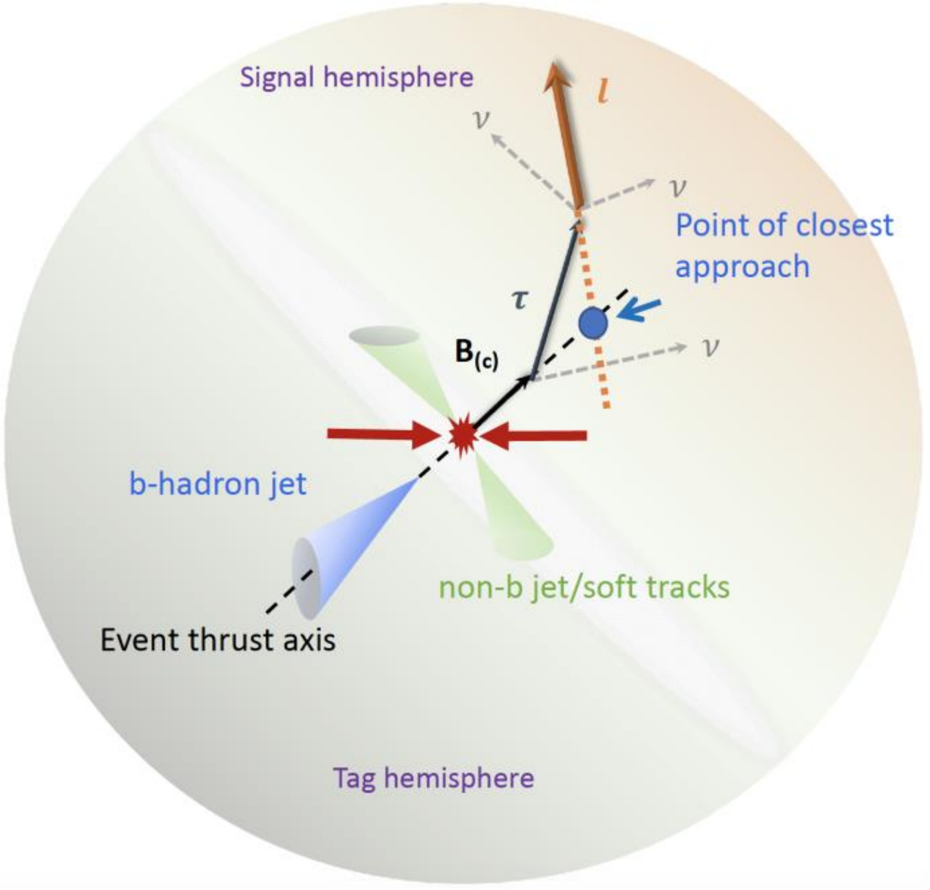
1. Identify the vertexes (primary & 2nd), find out the momentum direction of B
2. Estimate the B energy from the global energy-momentum conservation of each hemisphere
3. Find out the missing energy-momentum from mass-shell conditions

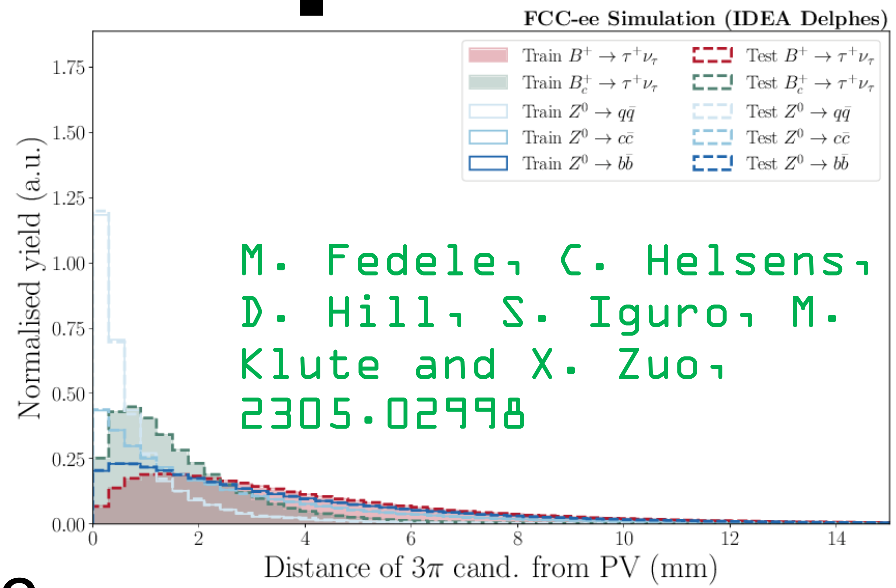
- The reconstructions of q^2 and B energy are sufficient ~ 1 GeV(2)



T. Zheng, J. Xu, L. Cao, D. Yu, W. Wang, S. Prell, Y.K.E. Cheung, M. Ruan, 2007.08234;

$B_c \rightarrow \tau\nu$ from both hadronic and leptonic final states

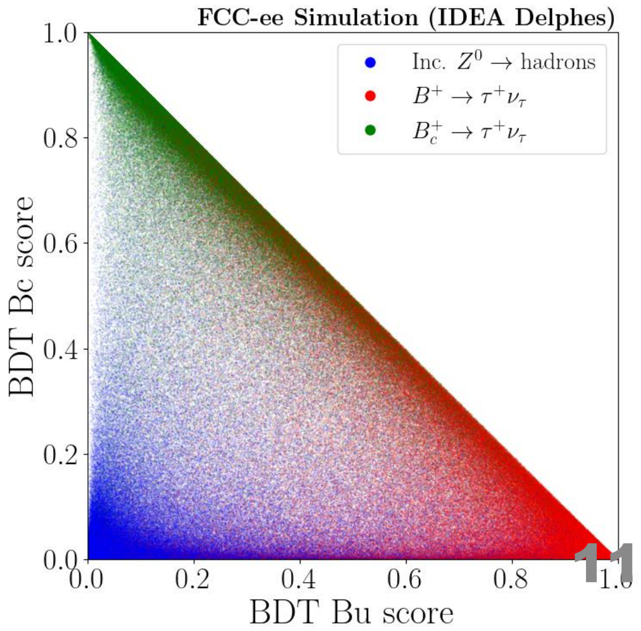




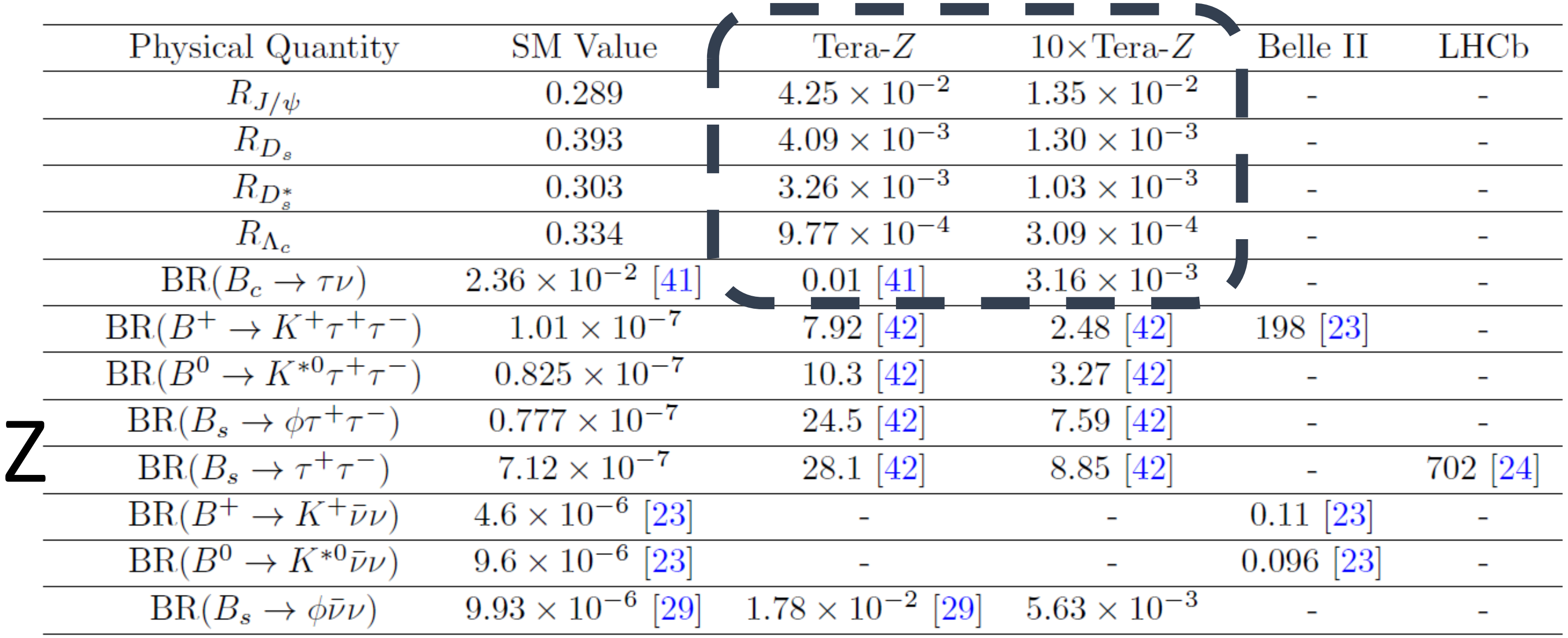
M. Fedele, C. Helsens, D. Hill, S. Iguro, M. Klute and X. Zuo, 2305.02998

- ➢ Hard to measure elsewhere, sensitive to CP-odd operators

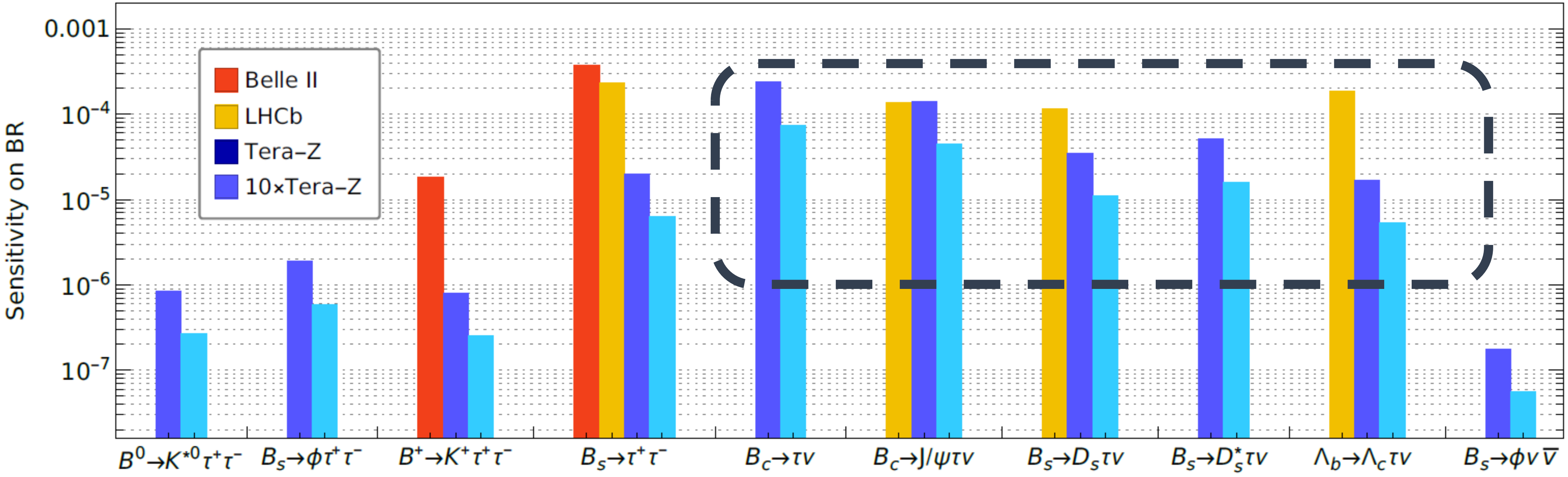
- ➢ Comparable performance from leptonic and hadronic channels



- Relative sensitivity of 1% or less achieved at a Tera-Z



Physical Quantity	SM Value	Tera-Z	10× Tera-Z	Belle II	LHCb
$R_{J/\psi}$	0.289	4.25×10^{-2}	1.35×10^{-2}	-	-
R_{D_s}	0.393	4.09×10^{-3}	1.30×10^{-3}	-	-
$R_{D_s^*}$	0.303	3.26×10^{-3}	1.03×10^{-3}	-	-
R_{Λ_c}	0.334	9.77×10^{-4}	3.09×10^{-4}	-	-
$\mathrm{BR}(B_c \to \tau\nu)$	2.36×10^{-2} [41]	0.01 [41]	3.16×10^{-3}	-	-
$\mathrm{BR}(B^+ \to K^+\tau^+\tau^-)$	1.01×10^{-7}	7.92 [42]	2.48 [42]	198 [23]	-
$\mathrm{BR}(B^0 \to K^{*0}\tau^+\tau^-)$	0.825×10^{-7}	10.3 [42]	3.27 [42]	-	-
$\mathrm{BR}(B_s \to \phi\tau^+\tau^-)$	0.777×10^{-7}	24.5 [42]	7.59 [42]	-	-
$\mathrm{BR}(B_s \to \tau^+\tau^-)$	7.12×10^{-7}	28.1 [42]	8.85 [42]	-	702 [24]
$\mathrm{BR}(B^+ \to K^+\bar{\nu}\nu)$	4.6×10^{-6} [23]	-	-	0.11 [23]	-
$\mathrm{BR}(B^0 \to K^{*0}\bar{\nu}\nu)$	9.6×10^{-6} [23]	-	-	0.096 [23]	-
$\mathrm{BR}(B_s \to \phi\bar{\nu}\nu)$	9.93×10^{-6} [29]	1.78×10^{-2} [29]	5.63×10^{-3}	-	-



EFT – Pheno Correspondence

$$\begin{aligned}\frac{R_{J/\psi}}{R^{\text{SM}}_{J/\psi}} = 1.0 + \text{Re}(&0.12C^{\tau}_{S_L} + 0.034|C^{\tau}_{S_L}|^2 - 0.12C^{\tau}_{S_R} - 0.068C^{\tau}_{S_L}C^{\tau *}_{S_R} + 0.034|C^{\tau}_{S_R}|^2 \\ &- 5.3C^{\tau}_{T} + 13|C^{\tau}_{T}|^2 - 1.9C^{\tau}_{V_R} - 0.12C^{\tau}_{S_L}C^{\tau *}_{V_R} + 0.12C^{\tau}_{S_R}C^{\tau *}_{V_R} \\ &+ 5.8C^{\tau}_{T}C^{\tau *}_{V_R} + 1.0|C^{\tau}_{V_R}|^2 + 2.0\delta C^{\tau}_{V_L} + 0.12C^{\tau}_{S_L}\delta C^{\tau *}_{V_L} \\ &- 0.12C^{\tau}_{S_R}\delta C^{\tau *}_{V_L} - 5.3C^{\tau}_{T}\delta C^{\tau *}_{V_L} - 1.9C^{\tau}_{V_R}\delta C^{\tau *}_{V_L} + 1.0|\delta C^{\tau}_{V_L}|^2)\ ,\end{aligned}$$

$$\begin{aligned}\frac{R_{D_s}}{R^{\text{SM}}_{D_s}} = 1.0 + \text{Re}(&1.6C^{\tau}_{S_L} + 1.2|C^{\tau}_{S_L}|^2 + 1.6C^{\tau}_{S_R} + 2.4C^{\tau}_{S_L}C^{\tau *}_{S_R} + 1.2|C^{\tau}_{S_R}|^2 \\ &+ 1.4C^{\tau}_{T} + 1.4|C^{\tau}_{T}|^2 + 2.0C^{\tau}_{V_R} + 1.6C^{\tau}_{S_L}C^{\tau *}_{V_R} + 1.6C^{\tau}_{S_R}C^{\tau *}_{V_R} \\ &+ 1.4C^{\tau}_{T}C^{\tau *}_{V_R} + 1.0|C^{\tau}_{V_R}|^2 + 2.0\delta C^{\tau}_{V_L} + 1.6C^{\tau}_{S_L}\delta C^{\tau *}_{V_L} \\ &+ 1.6C^{\tau}_{S_R}\delta C^{\tau *}_{V_L} + 1.4C^{\tau}_{T}\delta C^{\tau *}_{V_L} + 2.0C^{\tau}_{V_R}\delta C^{\tau *}_{V_L} + 1.0|\delta C^{\tau}_{V_L}|^2)\ ,\end{aligned}$$

$$\begin{aligned}\frac{R_{\Lambda_c}}{R^{\text{SM}}_{\Lambda_c}} = 1.0 + \text{Re}(&0.39C^{\tau}_{S_L} + 0.34|C^{\tau}_{S_L}|^2 + 0.49C^{\tau}_{S_R} + 0.61C^{\tau}_{S_L}C^{\tau *}_{S_R} + 0.34|C^{\tau}_{S_R}|^2 \\ &+ 1.1C^{\tau}_{T} + 12|C^{\tau}_{T}|^2 - 0.71C^{\tau}_{V_R} + 0.49C^{\tau}_{S_L}C^{\tau *}_{V_R} + 0.39C^{\tau}_{S_R}C^{\tau *}_{V_R} \\ &- 1.7C^{\tau}_{T}C^{\tau *}_{V_R} + 1.0|C^{\tau}_{V_R}|^2 + 2.0\delta C^{\tau}_{V_L} + 0.39C^{\tau}_{S_L}\delta C^{\tau *}_{V_L} \\ &+ 0.49C^{\tau}_{S_R}\delta C^{\tau *}_{V_L} + 1.1C^{\tau}_{T}\delta C^{\tau *}_{V_L} - 0.71C^{\tau}_{V_R}\delta C^{\tau *}_{V_L} + 1.0|\delta C^{\tau}_{V_L}|^2)\ .\end{aligned}$$

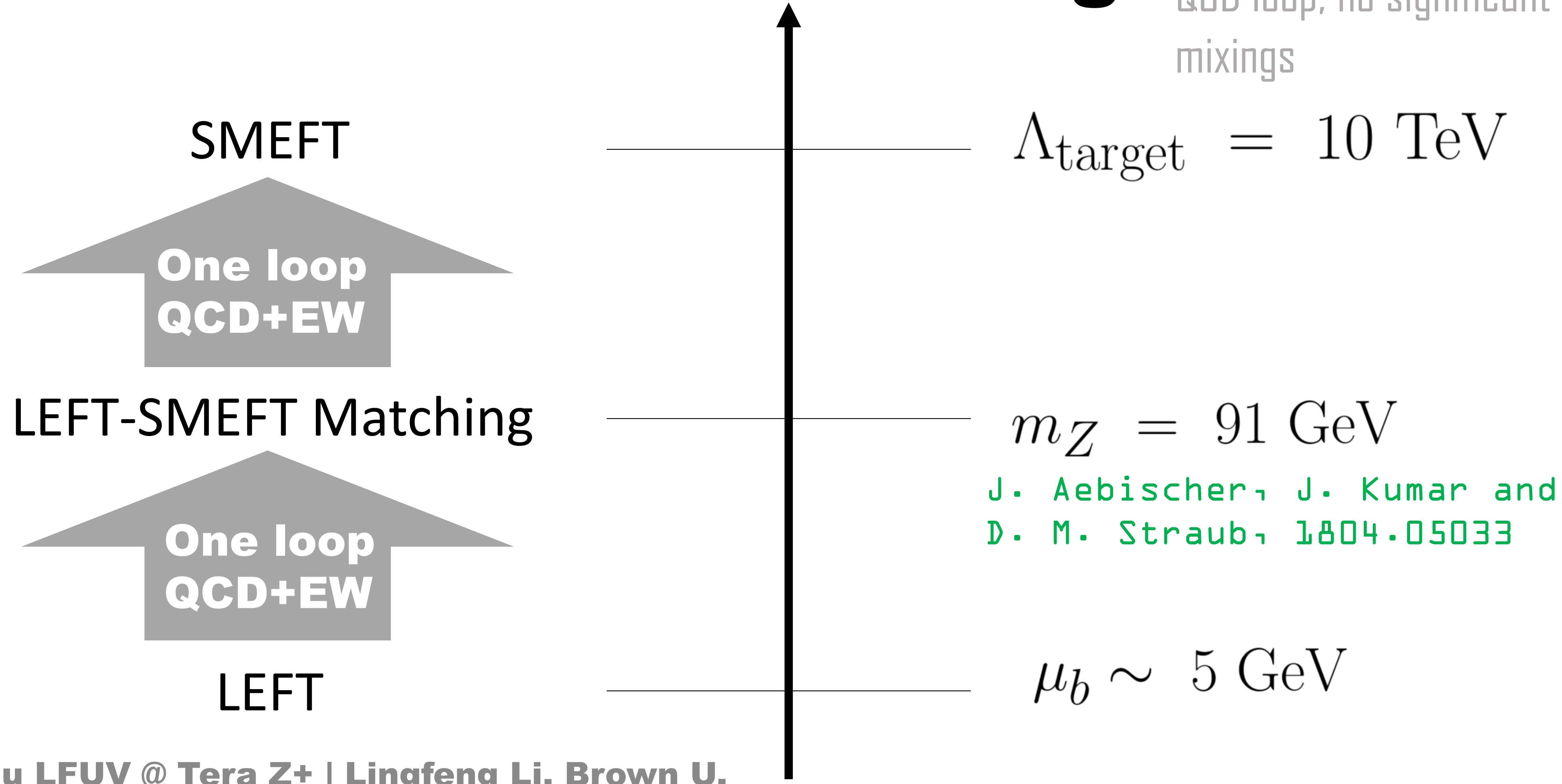
$$\begin{aligned}\frac{\text{BR}(B_s \to \tau^+\tau^-)}{\text{BR}(B_s \to \tau^+\tau^-)^{\text{SM}}} = 1.0 + \text{Re}(&0.46C'^{\tau}_{10} + 0.054|C'^{\tau}_{10}|^2 - 0.78C^{\tau}_{P} - 0.18C'^{\tau}_{10}C^{\tau *}_{P} \\ &+ 0.15|C^{\tau}_{P}|^2 + 0.78C'^{\tau}_{P} + 0.18C'^{\tau}_{10}C'^{\tau *}_{P} - 0.31C^{\tau}_{P}C'^{\tau *}_{P} \\ &+ 0.15|C'^{\tau}_{P}|^2 + 0.086|C^{\tau}_{S}|^2 - 0.17C^{\tau}_{S}C'^{\tau *}_{S} \\ &+ 0.086|C'^{\tau}_{S}|^2 - 0.46\delta C^{\tau}_{10} - 0.11C'^{\tau}_{10}\delta C^{\tau *}_{10} \\ &+ 0.18C^{\tau}_{P}\delta C^{\tau *}_{10} - 0.18C'^{\tau}_{P}\delta C^{\tau *}_{10} + 0.054|\delta C^{\tau}_{10}|^2)\ .\end{aligned}$$

θ	$J(\psi)$	D	D^*	D_s	D^*_s	Λ_b	B_c
$J(\psi)$	-	103°	3.01°	109°	1.96°	22.9°	81.8°
D	103°	-	102°	6.55°	102°	82.8°	90°
D^*	3.01°	102°	-	107°	4.45°	20.6°	81.2°
D_s	109°	6.55°	107°	-	108°	88°	90°
D^*_s	1.96°	102°	4.45°	108°	-	23.3°	82.8°
Λ_b	22.9°	82.8°	20.6°	88°	23.3°	-	79.6°
B_c	81.8°	90°	81.2°	90°	82.8°	79.6°	-

- Angles between channels in the theory space near the SM

LEFT to SMEFT Matching

Running dominated by the QCD loop, no significant mixings



SMEFT

$\Lambda_{\text{target}} = 10\ \text{TeV}$

One loop QCD+EW

LEFT-SMEFT Matching

$m_Z = 91\ \text{GeV}$

J. Aebischer, J. Kumar and D. M. Straub, 1804.05033

One loop QCD+EW

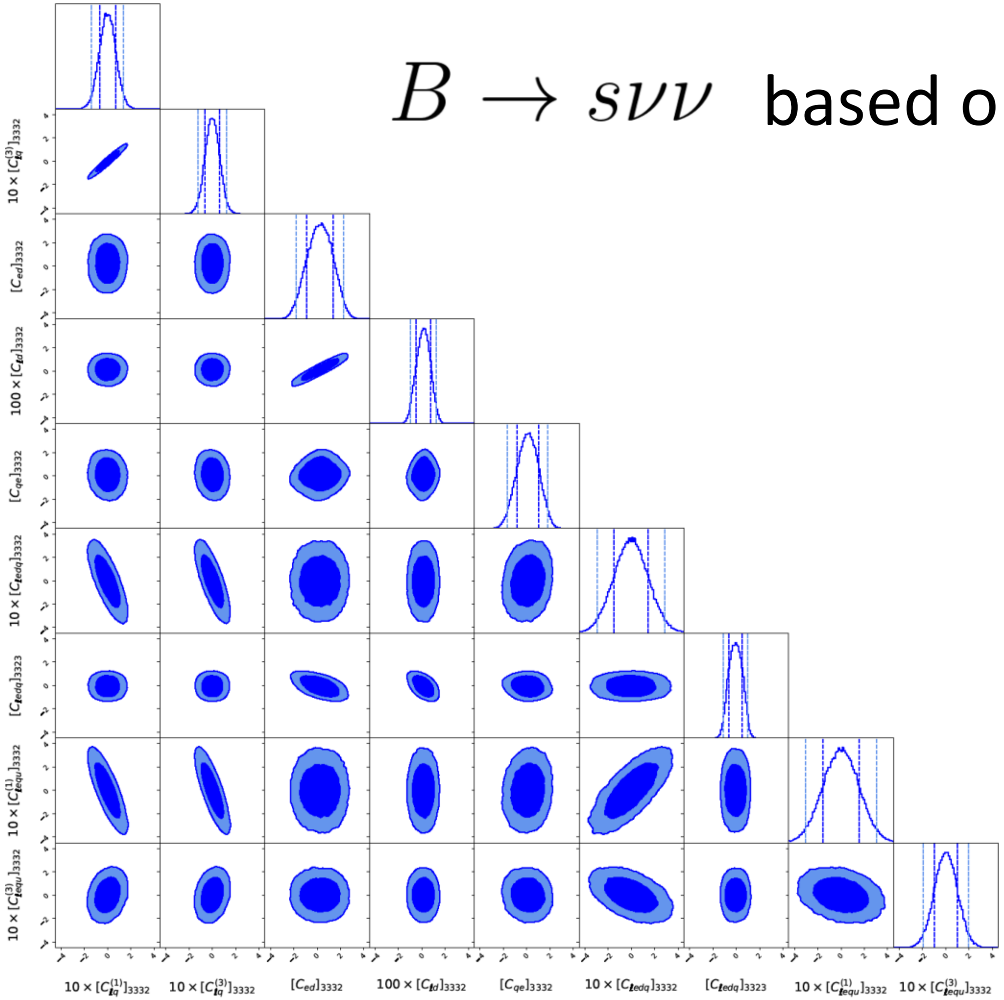
LEFT

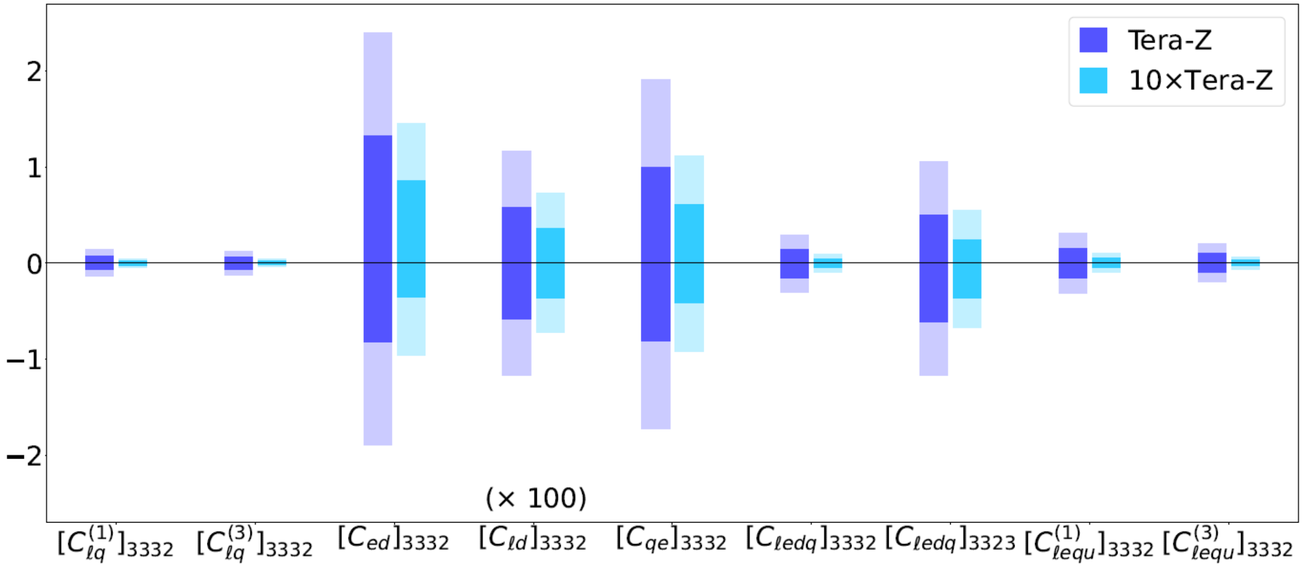
$\mu_b \sim 5\ \text{GeV}$

Posterior of SMEFT Wilson Coeff. with MCMC

$B \to s\nu\nu$ based on full simulation

LL, M. Ruan, Y. Wang, Y. Wang, 2201.07374

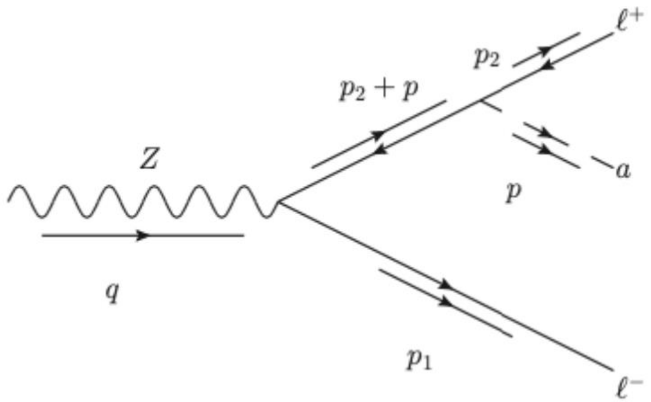




- Just enough constraints
- Sensitivity up to O(10) TeV*

*certainly model-dependent

At the Z pole: an ALP example

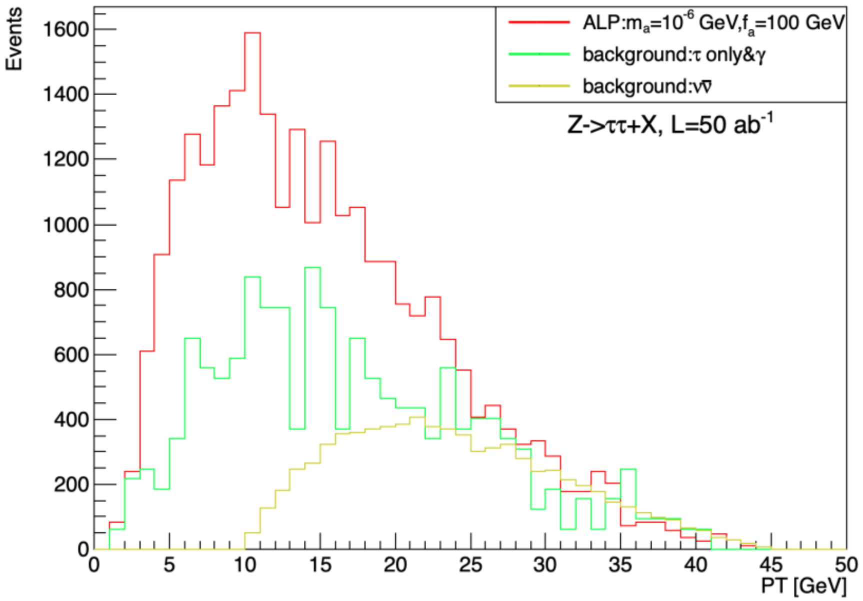


- A lot of interesting LFUV physics to be tested at the Z pole, usually targeting a much higher precision

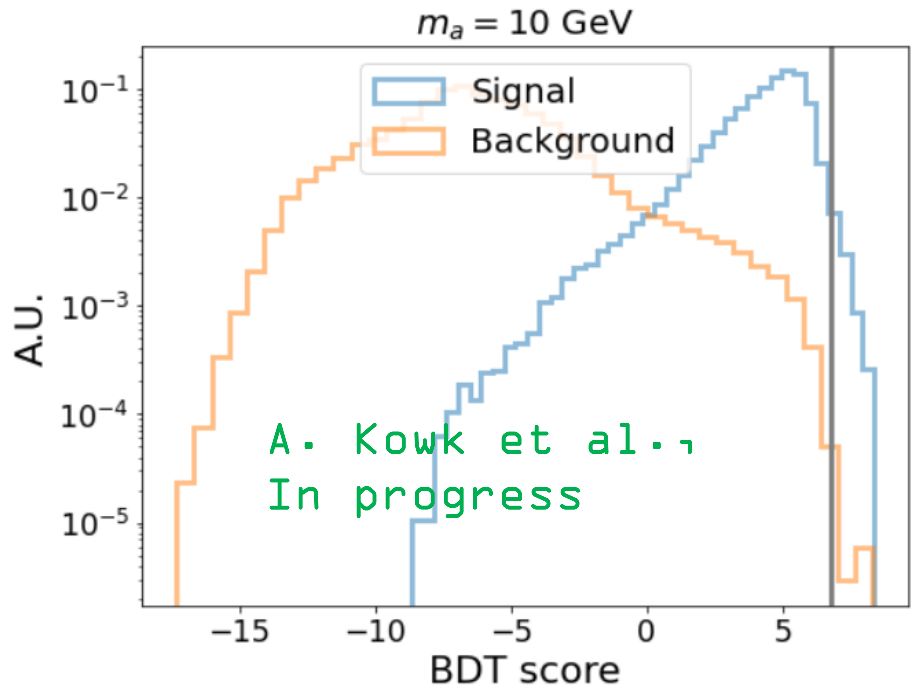
L. Calibbi, Z. Huang, S. Qin, Y. Yang, X. Yin, 2212.02818

- Invisible (delicate reconstruction) vs. displaced (straight forward)

- An ALP with f_a > TeV and LFUV τ coupling might be tested directly

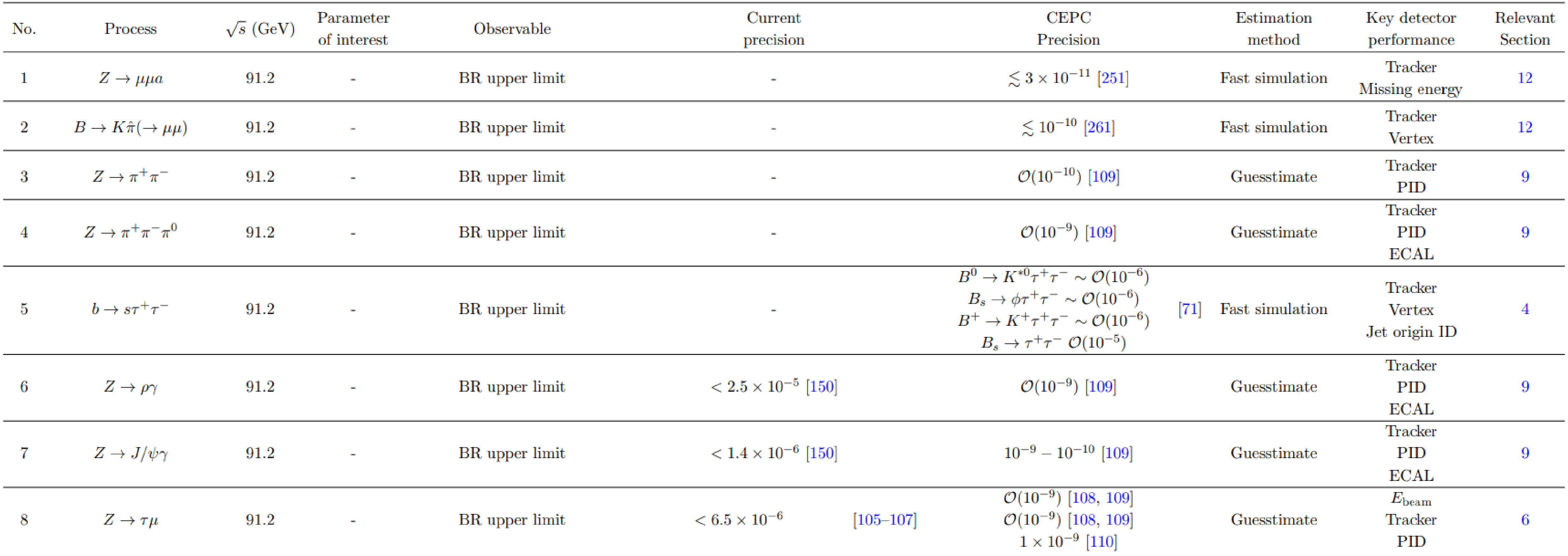


(d) PT in $e^+e^- \to Z^* \to \tau^+\tau^- + X$

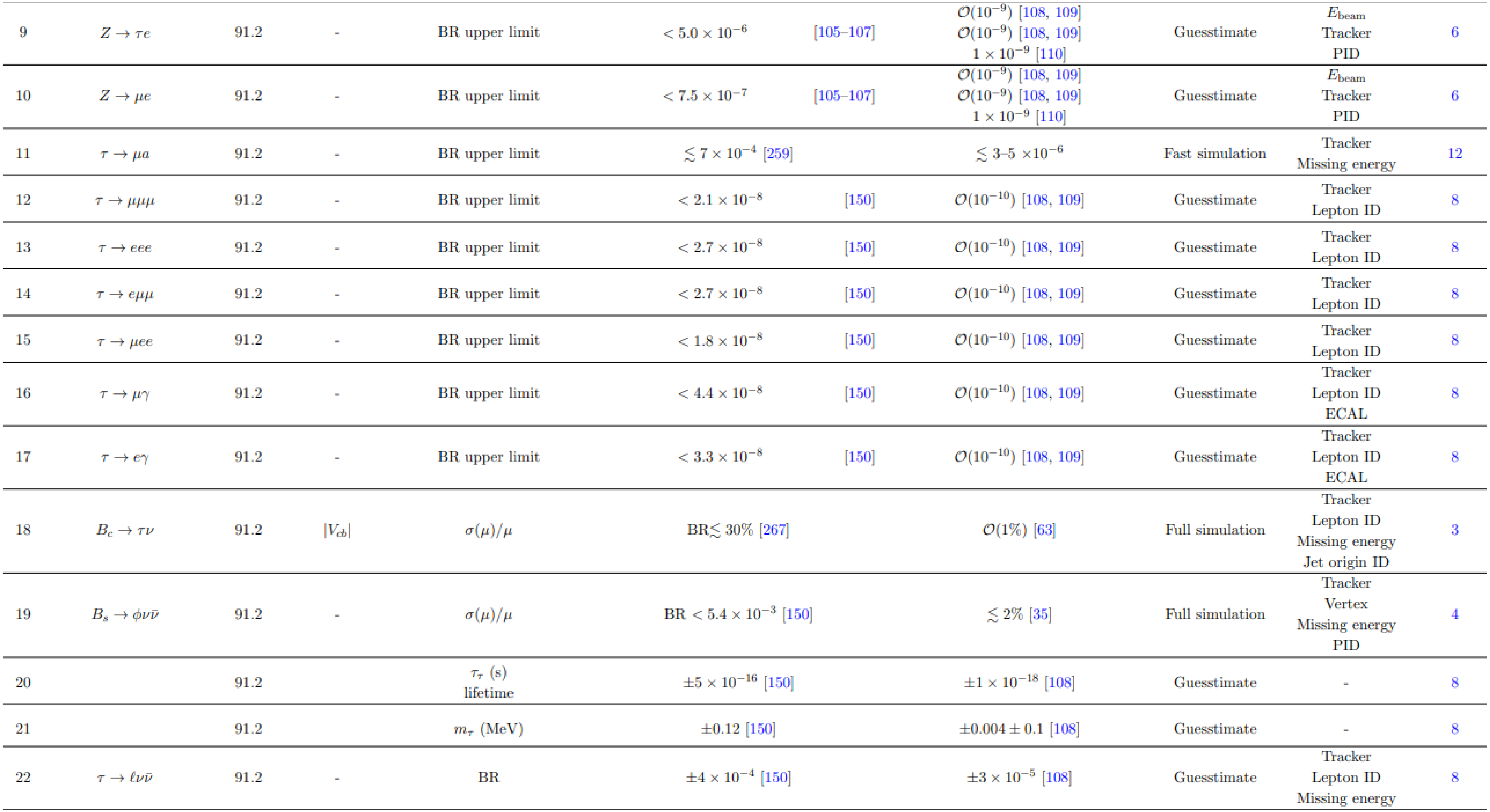


A. Kowk et al., In progress

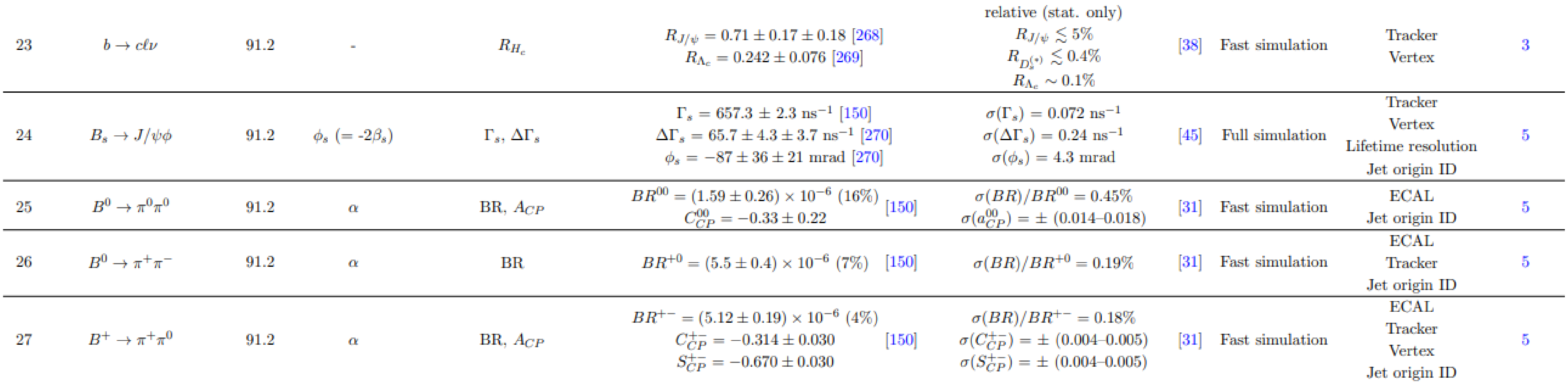
Other Interesting Physics



No.	Process	$\sqrt{s}$ (GeV)	Parameter of interest	Observable	Current precision	CEPC Precision	Estimation method	Key detector performance	Relevant Section
1	$Z \to \mu\mu a$	91.2	-	BR upper limit	-	$\lesssim 3 \times 10^{-11}$ [251]	Fast simulation	Tracker Missing energy	12
2	$B \to K\hat{\pi}(\to \mu\mu)$	91.2	-	BR upper limit	-	$\lesssim 10^{-10}$ [261]	Fast simulation	Tracker Vertex	12
3	$Z \to \pi^+\pi^-$	91.2	-	BR upper limit	-	$\mathcal{O}(10^{-10})$ [109]	Guesstimate	Tracker PID	9
4	$Z \to \pi^+\pi^-\pi^0$	91.2	-	BR upper limit	-	$\mathcal{O}(10^{-9})$ [109]	Guesstimate	Tracker PID ECAL	9
5	$b \to s\tau^+\tau^-$	91.2	-	BR upper limit	-	$B^0 \to K^{*0}\tau^+\tau^- \sim \mathcal{O}(10^{-6})$ $B_s \to \phi\tau^+\tau^- \sim \mathcal{O}(10^{-6})$ $B^+ \to K^+\tau^+\tau^- \sim \mathcal{O}(10^{-6})$ $B_s \to \tau^+\tau^-\ \mathcal{O}(10^{-5})$ [71]	Fast simulation	Tracker Vertex Jet origin ID	4
6	$Z \to \rho\gamma$	91.2	-	BR upper limit	$< 2.5 \times 10^{-5}$ [150]	$\mathcal{O}(10^{-9})$ [109]	Guesstimate	Tracker PID ECAL	9
7	$Z \to J/\psi\gamma$	91.2	-	BR upper limit	$< 1.4 \times 10^{-6}$ [150]	$10^{-9} - 10^{-10}$ [109]	Guesstimate	Tracker PID ECAL	9
8	$Z \to \tau\mu$	91.2	-	BR upper limit	$< 6.5 \times 10^{-6}$ [105–107]	$\mathcal{O}(10^{-9})$ [108, 109] $\mathcal{O}(10^{-9})$ [108, 109] 1×10^{-9} [110]	Guesstimate	E_{beam} Tracker PID	6



9	$Z \to \tau e$	91.2	-	BR upper limit	$< 5.0 \times 10^{-6}$ [105–107]	$\mathcal{O}(10^{-9})$ [108, 109] $\mathcal{O}(10^{-9})$ [108, 109] 1×10^{-9} [110]	Guesstimate	E_{beam} Tracker PID	6
10	$Z \to \mu e$	91.2	-	BR upper limit	$< 7.5 \times 10^{-7}$ [105–107]	$\mathcal{O}(10^{-9})$ [108, 109] $\mathcal{O}(10^{-9})$ [108, 109] 1×10^{-9} [110]	Guesstimate	E_{beam} Tracker PID	6
11	$\tau \to \mu a$	91.2	-	BR upper limit	$\lesssim 7 \times 10^{-4}$ [259]	$\lesssim$ 3–5 $\times 10^{-6}$	Fast simulation	Tracker Missing energy	12
12	$\tau \to \mu\mu\mu$	91.2	-	BR upper limit	$< 2.1 \times 10^{-8}$ [150]	$\mathcal{O}(10^{-10})$ [108, 109]	Guesstimate	Tracker Lepton ID	8
13	$\tau \to eee$	91.2	-	BR upper limit	$< 2.7 \times 10^{-8}$ [150]	$\mathcal{O}(10^{-10})$ [108, 109]	Guesstimate	Tracker Lepton ID	8
14	$\tau \to e\mu\mu$	91.2	-	BR upper limit	$< 2.7 \times 10^{-8}$ [150]	$\mathcal{O}(10^{-10})$ [108, 109]	Guesstimate	Tracker Lepton ID	8
15	$\tau \to \mu ee$	91.2	-	BR upper limit	$< 1.8 \times 10^{-8}$ [150]	$\mathcal{O}(10^{-10})$ [108, 109]	Guesstimate	Tracker Lepton ID	8
16	$\tau \to \mu\gamma$	91.2	-	BR upper limit	$< 4.4 \times 10^{-8}$ [150]	$\mathcal{O}(10^{-10})$ [108, 109]	Guesstimate	Tracker Lepton ID ECAL	8
17	$\tau \to e\gamma$	91.2	-	BR upper limit	$< 3.3 \times 10^{-8}$ [150]	$\mathcal{O}(10^{-10})$ [108, 109]	Guesstimate	Tracker Lepton ID ECAL	8
18	$B_c \to \tau\nu$	91.2	$\lvert V_{cb}\rvert$	$\sigma(\mu)/\mu$	BR$\lesssim 30\%$ [267]	$\mathcal{O}(1\%)$ [63]	Full simulation	Tracker Lepton ID Missing energy Jet origin ID	3
19	$B_s \to \phi\nu\bar{\nu}$	91.2	-	$\sigma(\mu)/\mu$	BR $< 5.4 \times 10^{-3}$ [150]	$\lesssim 2\%$ [35]	Full simulation	Tracker Vertex Missing energy PID	4
20		91.2		τ_τ (s) lifetime	$\pm 5 \times 10^{-16}$ [150]	$\pm 1 \times 10^{-18}$ [108]	Guesstimate	-	8
21		91.2		m_τ (MeV)	± 0.12 [150]	$\pm 0.004 \pm 0.1$ [108]	Guesstimate	-	8
22	$\tau \to \ell\nu\bar{\nu}$	91.2	-	BR	$\pm 4 \times 10^{-4}$ [150]	$\pm 3 \times 10^{-5}$ [108]	Guesstimate	Tracker Lepton ID Missing energy	8



23	$b \to c\ell\nu$	91.2	-	R_{H_c}	$R_{J/\psi} = 0.71 \pm 0.17 \pm 0.18$ [268] $R_{\Lambda_c} = 0.242 \pm 0.076$ [269]		relative (stat. only) $R_{J/\psi} \lesssim 5\%$ $R_{D_s^{(*)}} \lesssim 0.4\%$ $R_{\Lambda_c} \sim 0.1\%$	[38]	Fast simulation	Tracker Vertex	3
24	$B_s \to J/\psi\phi$	91.2	ϕ_s (= $-2\beta_s$)	Γ_s, $\Delta\Gamma_s$	$\Gamma_s = 657.3 \pm 2.3$ ns^{-1} [150] $\Delta\Gamma_s = 65.7 \pm 4.3 \pm 3.7$ ns^{-1} [270] $\phi_s = -87 \pm 36 \pm 21$ mrad [270]		$\sigma(\Gamma_s) = 0.072$ ns^{-1} $\sigma(\Delta\Gamma_s) = 0.24$ ns^{-1} $\sigma(\phi_s) = 4.3$ mrad	[45]	Full simulation	Tracker Vertex Lifetime resolution Jet origin ID	5
25	$B^0 \to \pi^0\pi^0$	91.2	α	BR, A_{CP}	$BR^{00} = (1.59 \pm 0.26) \times 10^{-6}$ (16%) $C_{CP}^{00} = -0.33 \pm 0.22$	[150]	$\sigma(BR)/BR^{00} = 0.45\%$ $\sigma(a_{CP}^{00}) = \pm$ (0.014–0.018)	[31]	Fast simulation	ECAL Jet origin ID	5
26	$B^0 \to \pi^+\pi^-$	91.2	α	BR	$BR^{+0} = (5.5 \pm 0.4) \times 10^{-6}$ (7%)	[150]	$\sigma(BR)/BR^{+0} = 0.19\%$	[31]	Fast simulation	ECAL Tracker Jet origin ID	5
27	$B^+ \to \pi^+\pi^0$	91.2	α	BR, A_{CP}	$BR^{+-} = (5.12 \pm 0.19) \times 10^{-6}$ (4%) $C_{CP}^{+-} = -0.314 \pm 0.030$ $S_{CP}^{+-} = -0.670 \pm 0.030$	[150]	$\sigma(BR)/BR^{+-} = 0.18\%$ $\sigma(C_{CP}^{+-}) = \pm$ (0.004–0.005) $\sigma(S_{CP}^{+-}) = \pm$ (0.004–0.005)	[31]	Fast simulation	ECAL Tracker Vertex Jet origin ID	5

and more…….

A flavor physics white paper at a Tera-Z+ is about to launch

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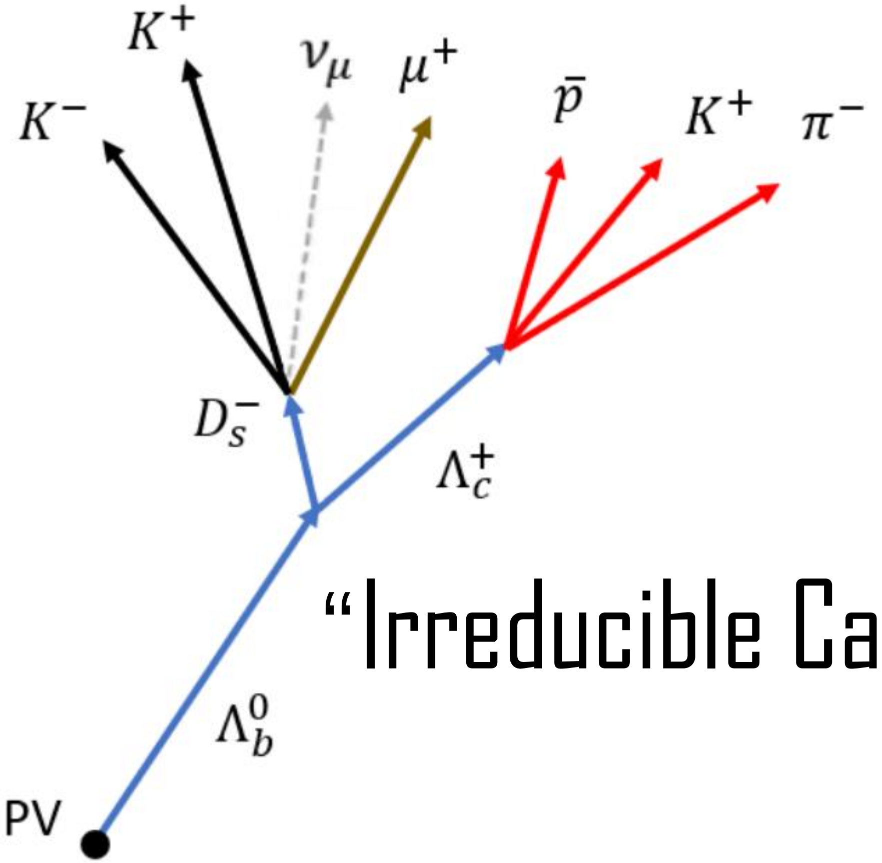
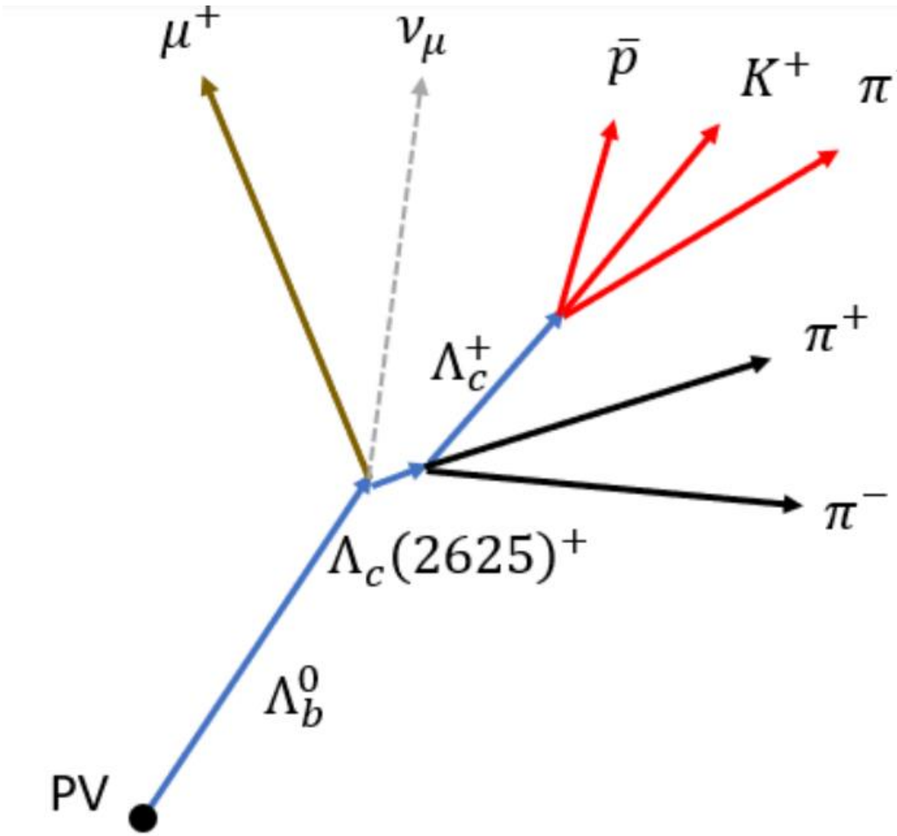
Backup Slides

Backgrounds



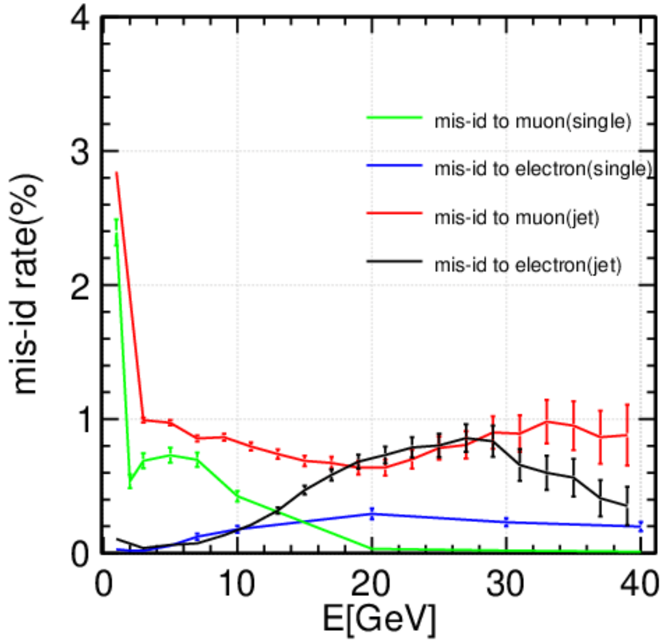
“Irreducible Cascades”

“X_c Inclusive”



Backgrounds are extracted from inclusive MC simulations

Backgrounds (II)

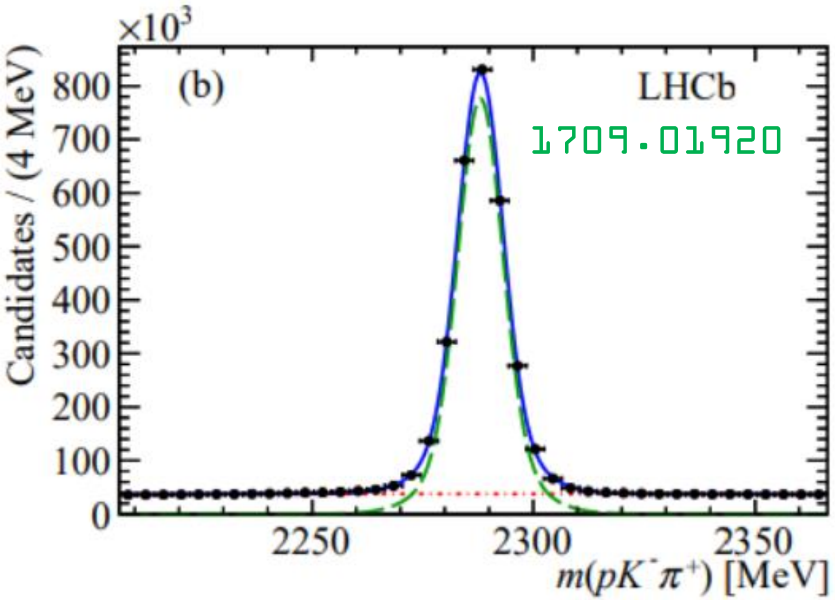


❑Muon mis-PID from charged pion are set to 1% according to CEPC full sim.

D. Yu, T. Zheng, M.Ruan, 2105.01246

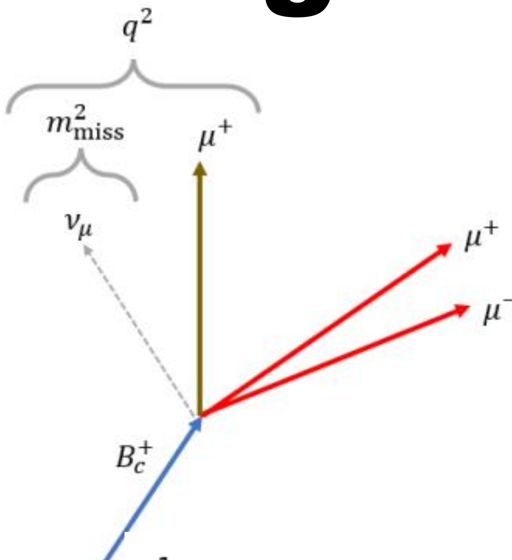
❑Fake Xc resonance (also include PID) estimated from LHCb sidebands

- ➢The effect is negligible

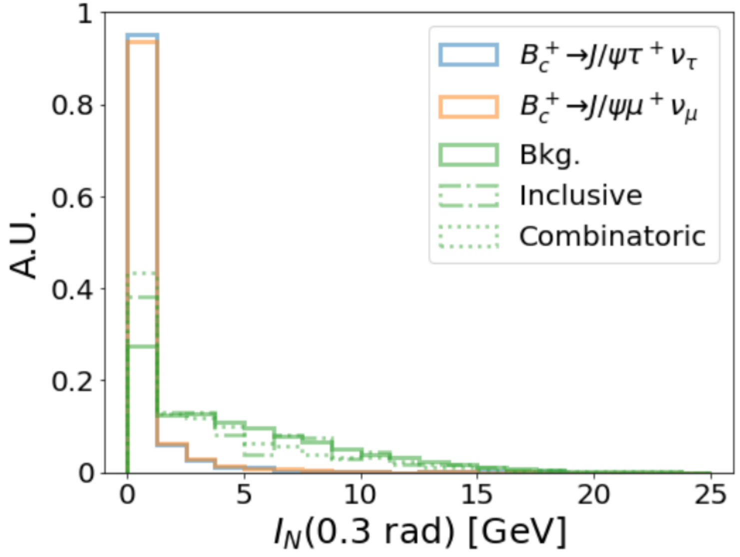


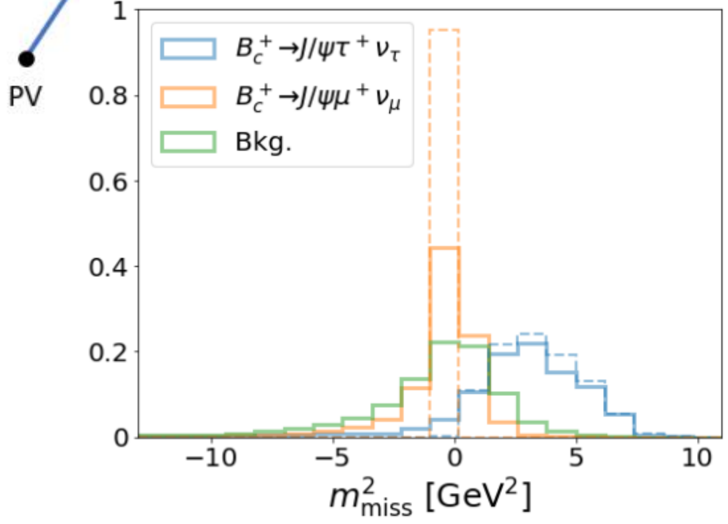
1709.01920

Signal-Background Discrimination



μ/τ separation due to different # of neutrinos and thus missing mass





Inclusive and cascade background removal from extra radiation in the cone