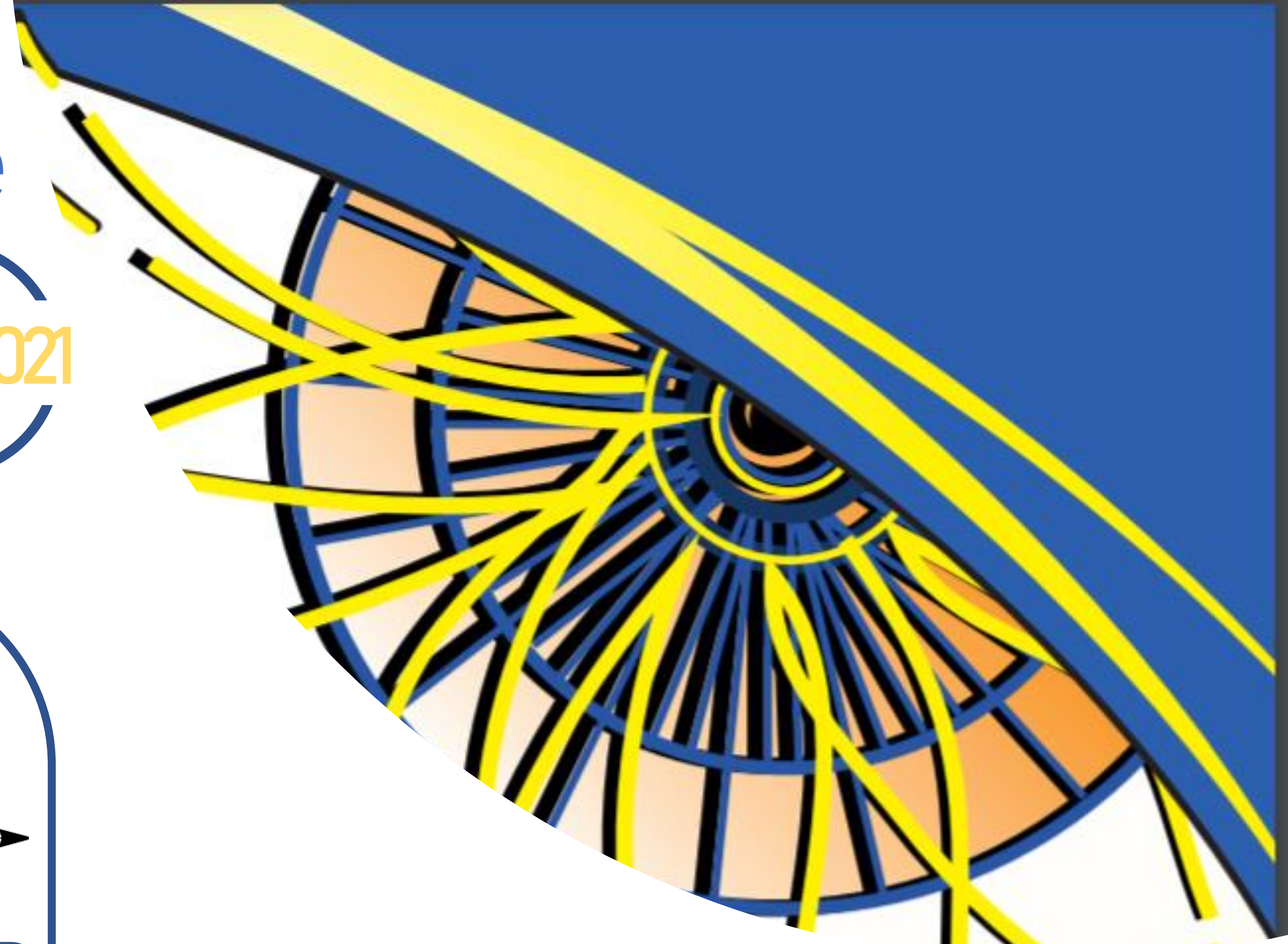


LFU Tests at the Z Pole

Measurement of $b \rightarrow \tau$ and beyond

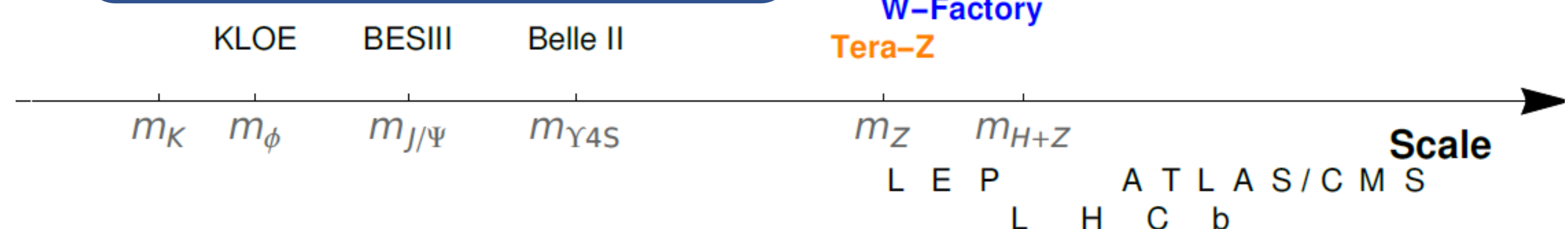
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Introduction

Z-Factory of ee-colliders, e.g. FCC-ee, CEPC and ILC. Up to $O(10^{13})$ Z-bosons will be produced.

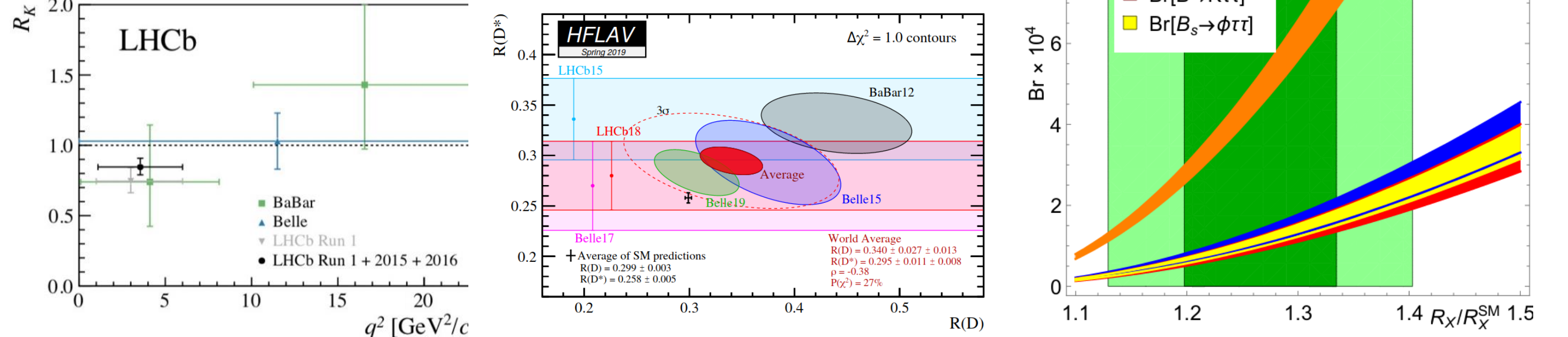


Channel	Belle II	LHCb	Giga-Z	Tera-Z	10x Tera-Z
B^0, \bar{B}^0	5.3×10^{10}	$\sim 6 \times 10^{13}$	1.2×10^8	1.2×10^{11}	1.2×10^{12}
B^\pm	5.6×10^{10}	$\sim 6 \times 10^{13}$	1.2×10^8	1.2×10^{11}	1.2×10^{12}
B_s, \bar{B}_s	5.7×10^8	$\sim 2 \times 10^{13}$	3.2×10^7	3.2×10^{10}	3.2×10^{11}
B_c^\pm	-	$\sim 4 \times 10^{11}$	2.2×10^5	2.2×10^8	2.2×10^9
$\Lambda_b, \bar{\Lambda}_b$	-	$\sim 2 \times 10^{13}$	1.0×10^7	1.0×10^{10}	1.0×10^{11}

Producing all kinds of b-hadrons. Sufficient energy stems from $m_Z \sim 91$ GeV, allowing production with sufficiently boosted tracks.

Recent hints of Lepton flavor universality (LFU) violation:

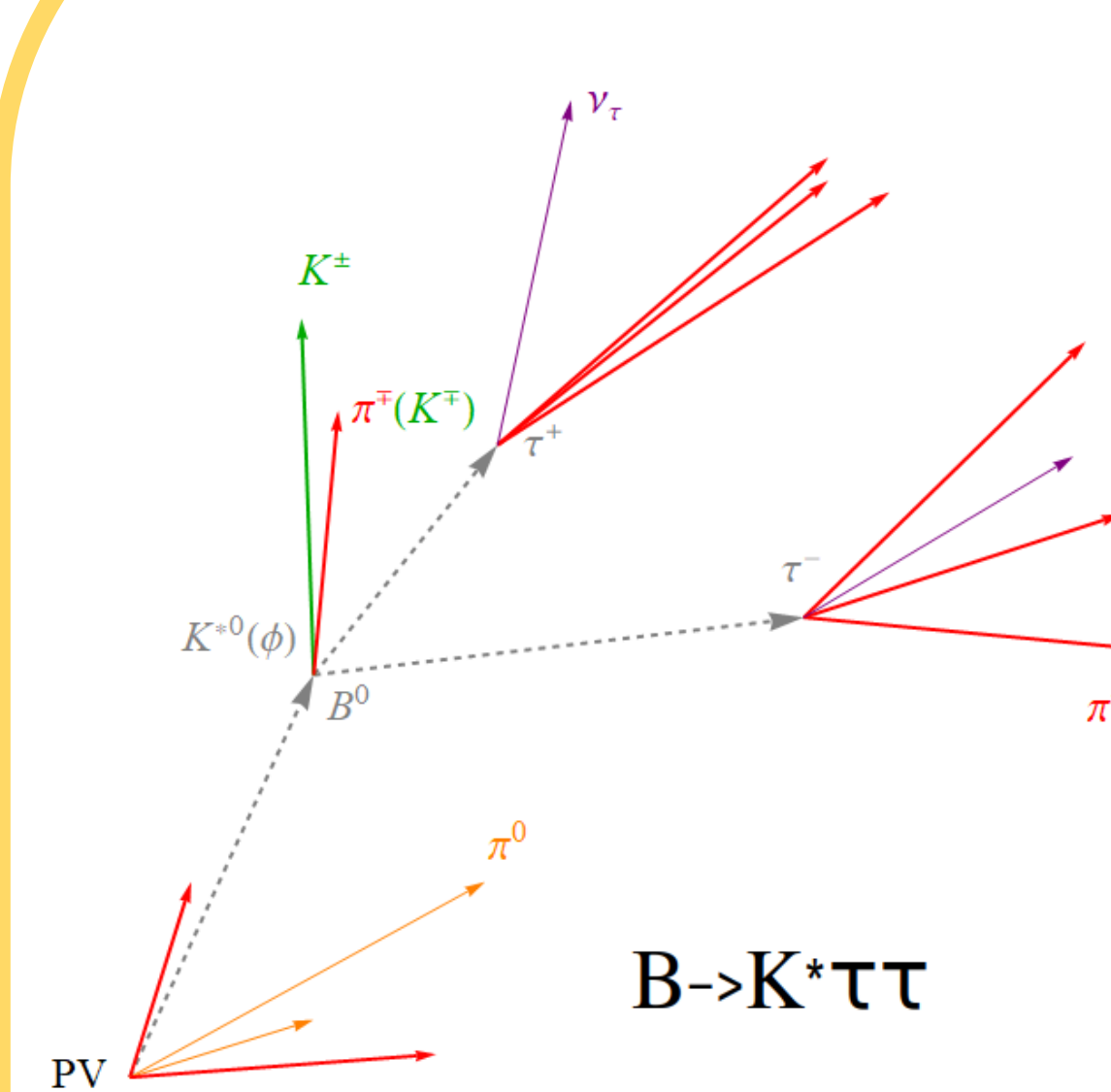
- Charged current anomalies (τ vs. μ/e): $R_D, R_{D^*}, R_{J/\psi}$.
- Neutral current anomalies (μ vs. e): R_K, R_{K^*} .



Many new physics scenarios plausible: (leptoquarks, new bosons, SUSY...)

- Models resolving the FCCC $b \rightarrow c\tau\nu$ anomaly introduce $O(0.1)$ correction to SM coupling at tree level.
- Enhancing $b \rightarrow s\tau\tau$ rates by ~ 3 orders: more than a smoking gun!
- Still compatible with stringent FCNC $b \rightarrow sv$ limits ($O(10^{-5})$)

Simulation & Analysis

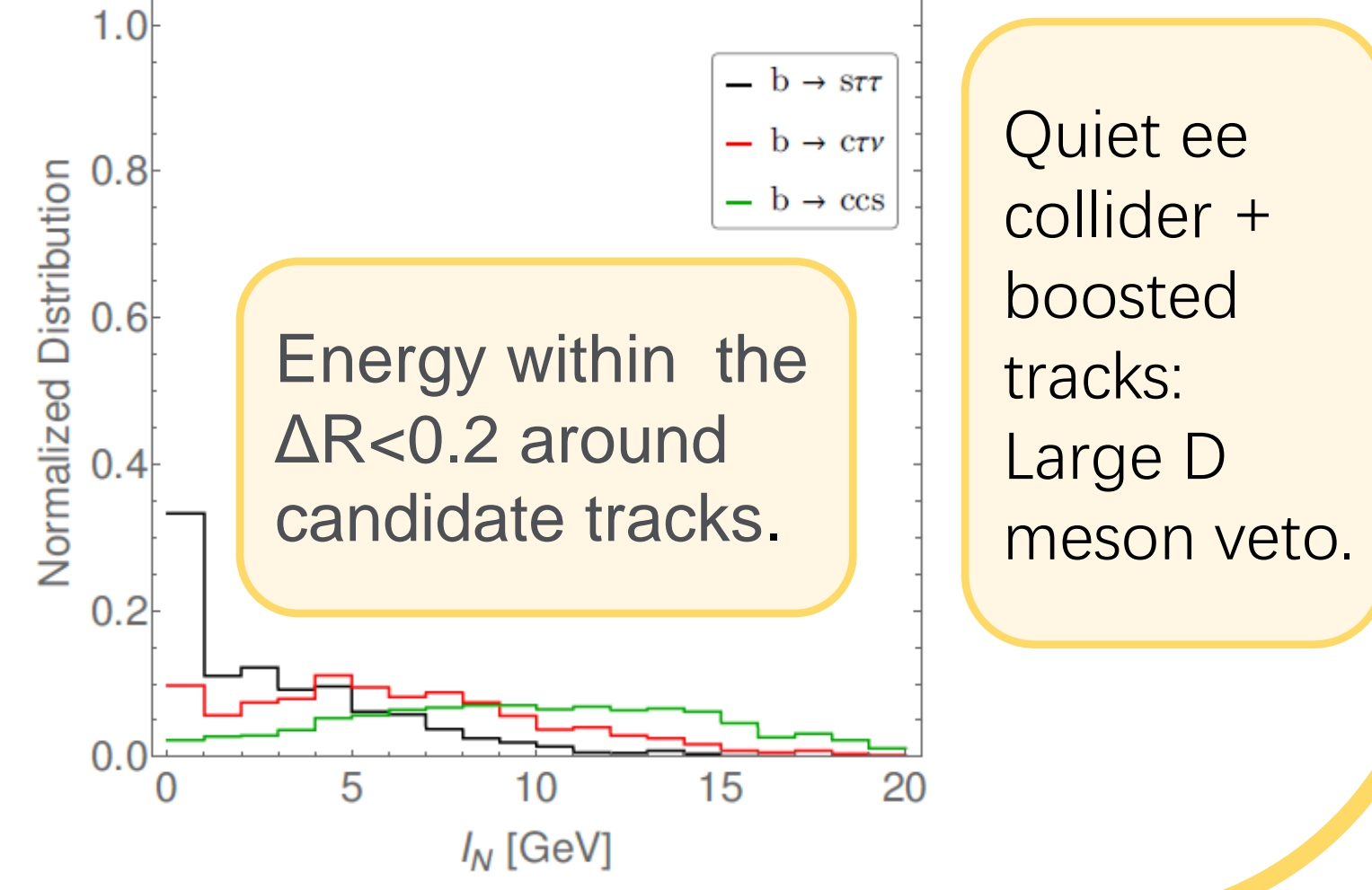


In SM, large backgrounds from D mesons faking τ : $3\pi+X$ decays of D mesons is common!

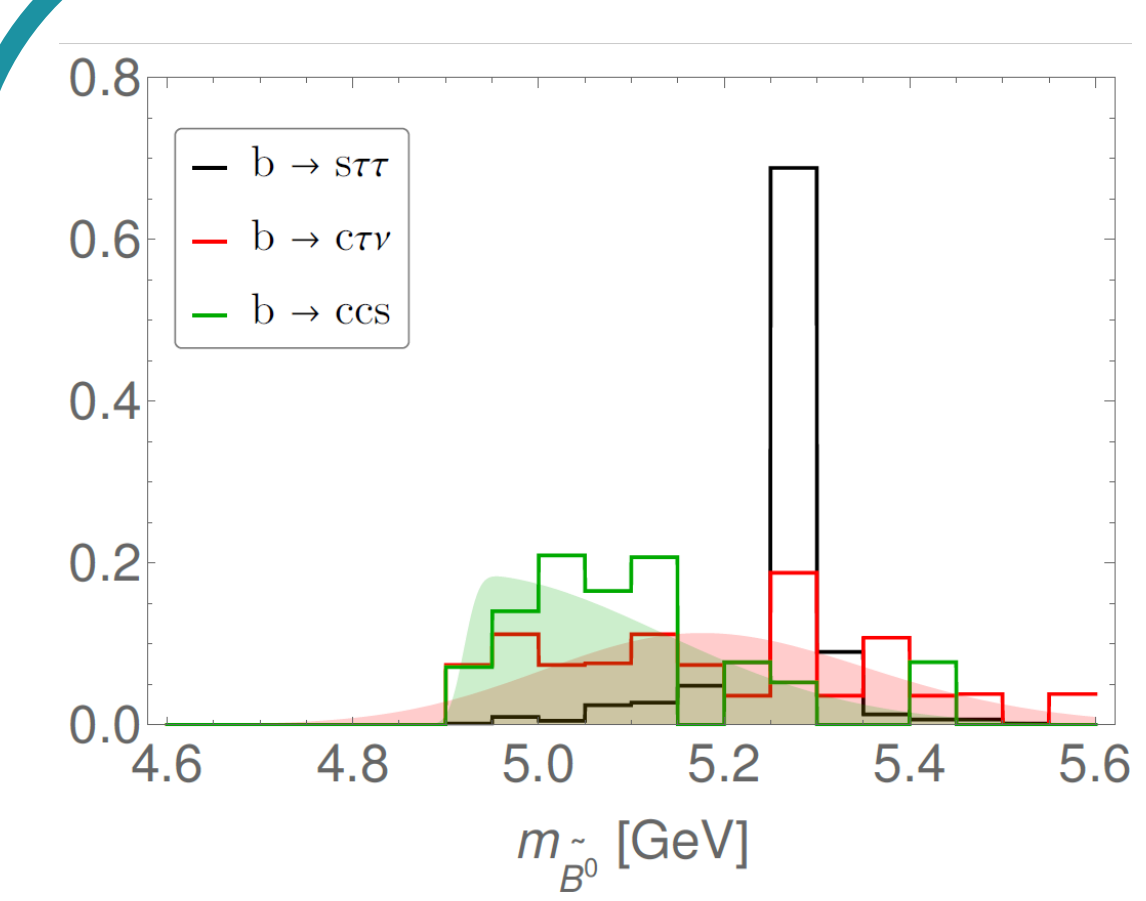
Type	Channel	Color	$s\bar{s}$	τ	BR
$b \rightarrow c\bar{s}$	$B^0 \rightarrow K^{*0} D^{(*)+} D^{(*)-}$				1.2×10^{-2}
	$B_s \rightarrow K^{*0} D^{(*)+} D_s^{(*)-}$				1.2×10^{-2}
	$B_s \rightarrow \bar{K}^{*0} D_s^{(*)+} D^{(*)-}$				1.2×10^{-2}
	$B^0 \rightarrow K^{*0} D_s^{(*)+} D_s^{(*)-}$				1.6×10^{-3}
$b \rightarrow c\tau\nu$	$B^0 \rightarrow K^{*0} D_s^{(*)-} \tau^+ \nu$		✓	✓	3.0×10^{-5}
	$B_s \rightarrow \bar{K}^{*0} D^{(*)-} \tau^+ \nu$		✓	✓	4.6×10^{-4}

The $3\tau\nu$ decay of τ provides information of each decay vertex, given the high boost and tracking precision at the Z pole.

- 6 kinetic constraints + 2 mass-shell conditions,
- Fully reconstruct m_B



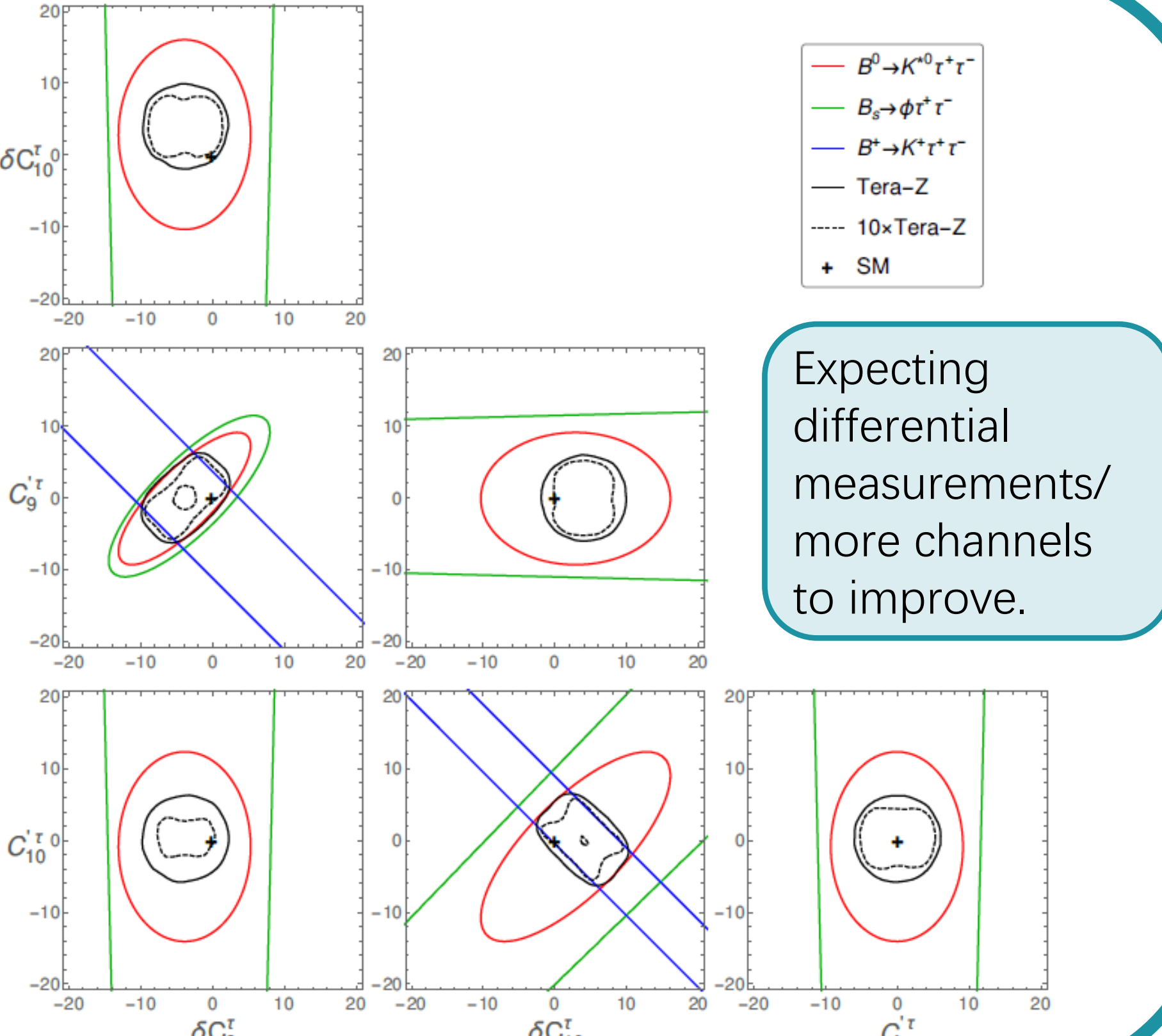
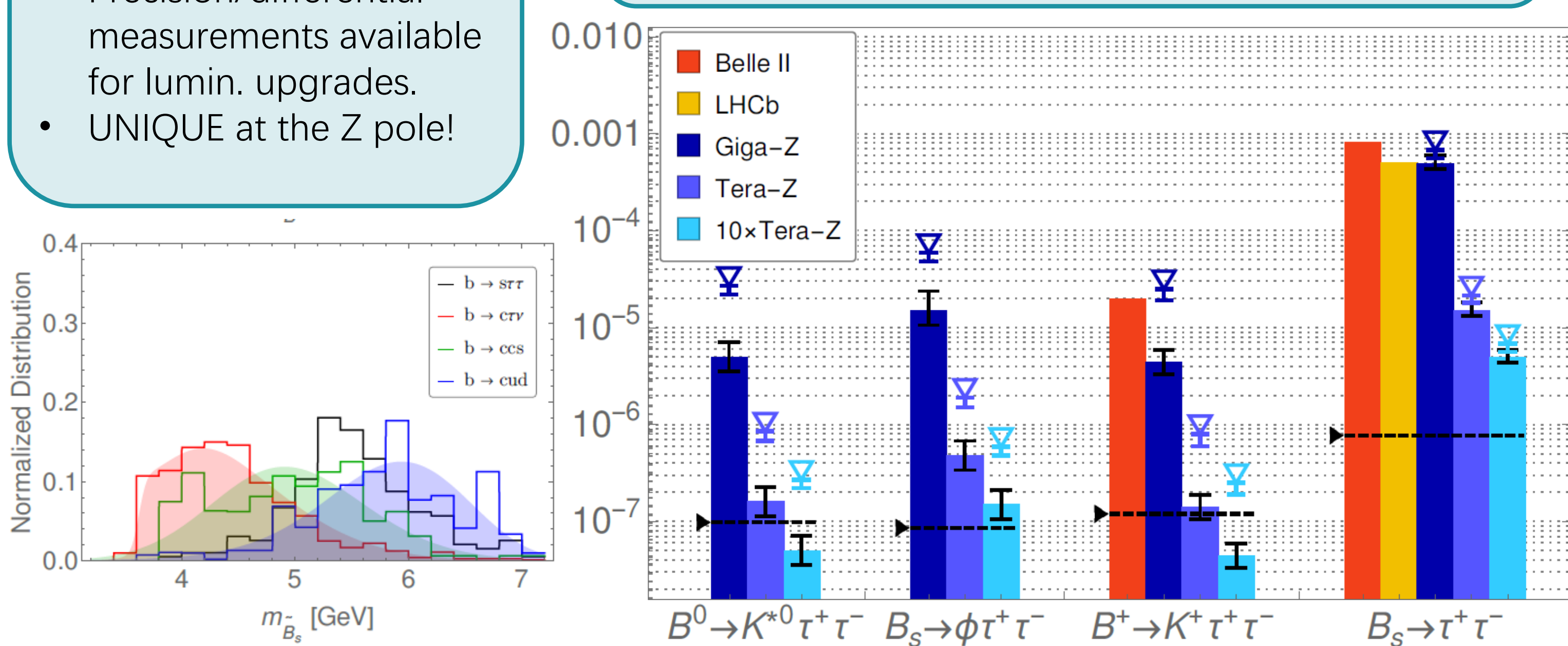
Results & Physical Interpretation



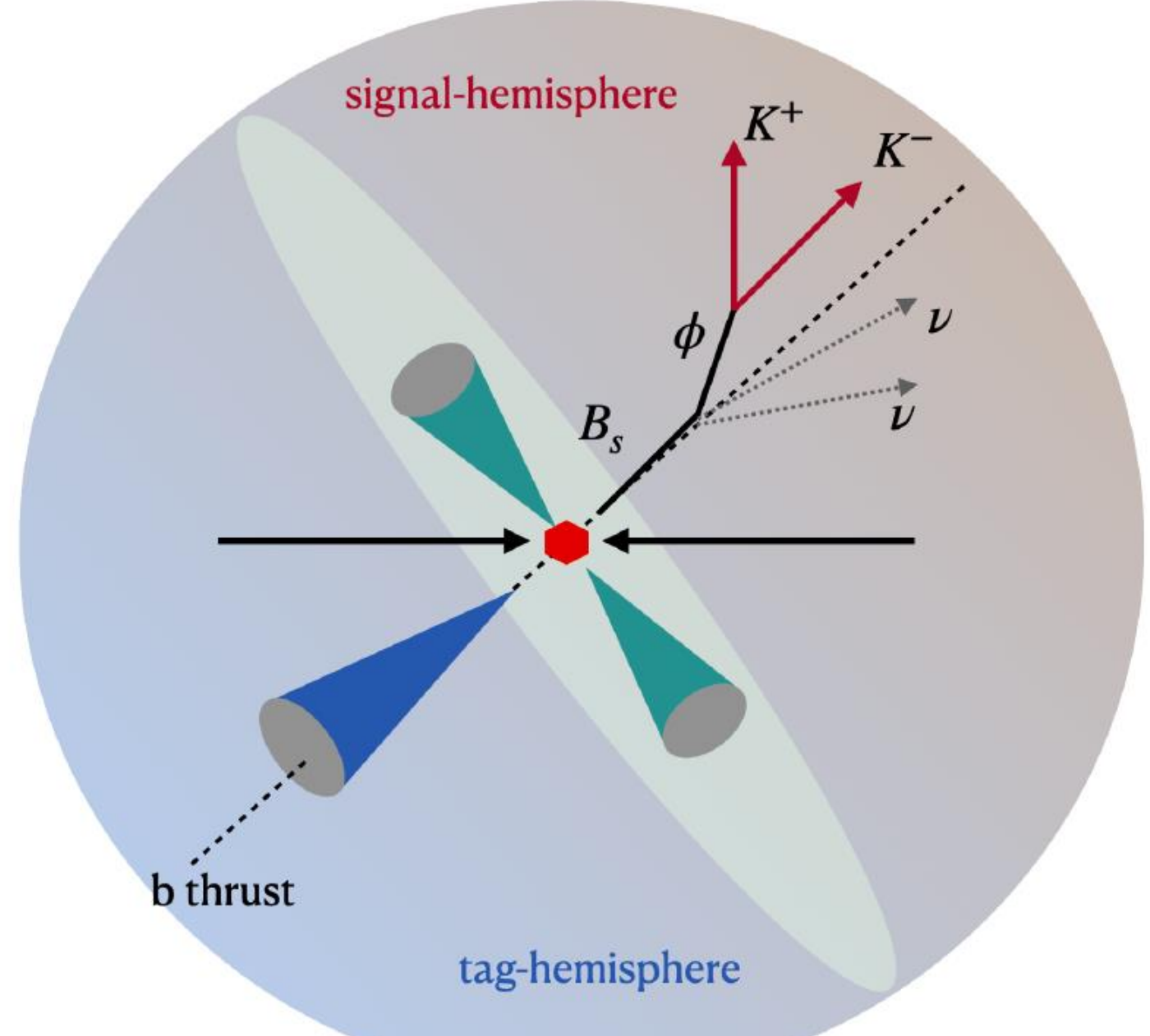
- At Tera-Z, able to see $O(1)$ deviations.
- Precision/differential measurements available for lumin. upgrades.
- UNIQUE at the Z pole!

Constraints on the 4 Wilson coefficients of EFT:

- Vector and pseudoscalar modes both relevant.
- Current limit of $O(10^3) \rightarrow O(10)$.

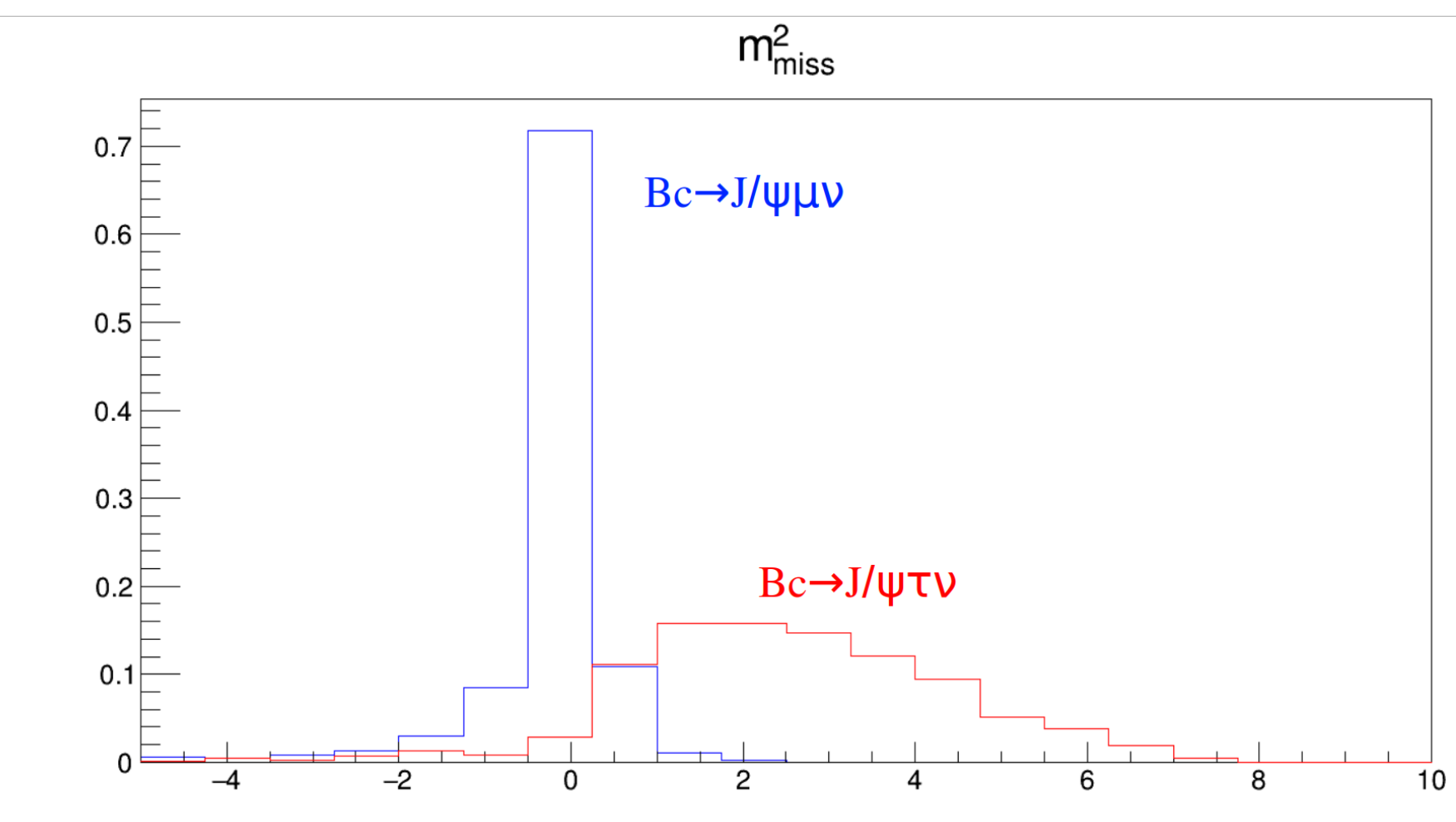


Future Prospect



Multiple searches using FCCC $b \rightarrow c\tau\nu$ decays are in preparation

- $R_{J/\psi}, R_{D_s^*}, R_{D_{S^{*+}}}$, and R_{Λ_c} !
- Good reconstruction quality ensuring S/B ~ 1 .



References

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