



CEPC New Physics Studies- BSM Higgs

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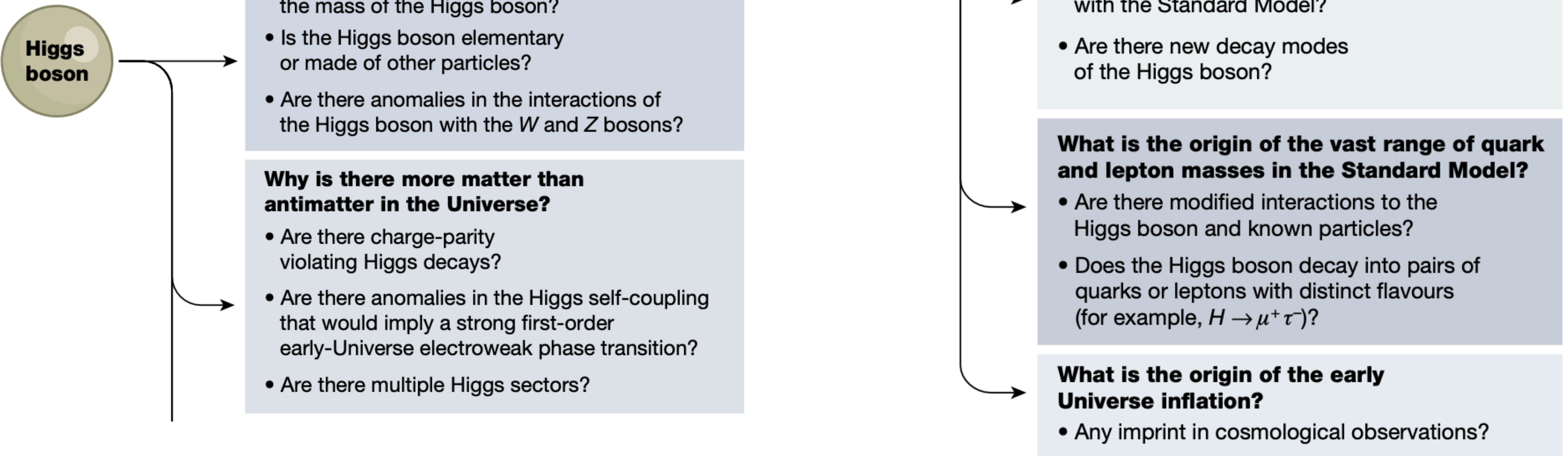
The 9th China LHC Physics Workshop (CLHCP2023) @ SJTU
2023-11-18

Outline

- Introduction
- BSM Higgs studies
 - Higgs Exotic Decay
 - Exotic Light Higgs Searches
 - Dark Sector scalars or pseudo-scalars at Z-Factory
 - Higgs invisible decay for Higgs Portal Dark Matter
- Summary

The Higgs boson turns ten in 2012

G.P. Salam, L.T. Wang, G. Zanderighi, Nature Perspectives 2022



- Higgs could be the key of the particle physics open questions

The Higgs boson turns ten in 2012

Higgs boson

Why is the electroweak interaction so much stronger than gravity?

- Are there new particles close to the mass of the Higgs boson?
- Is the Higgs boson elementary or made of other particles?
- Are there anomalies in the interactions of the Higgs boson with the W and Z bosons?

Why is there more matter than antimatter in the Universe?

- Are there charge-parity violating Higgs decays?
- Are there anomalies in the Higgs self-coupling that would imply a strong first-order early-Universe electroweak phase transition?
- Are there multiple Higgs sectors?

What is dark matter?

- Can the Higgs boson provide a portal to dark matter or a dark sector?
- Is the Higgs lifetime consistent with the Standard Model?
- Are there new decay modes of the Higgs boson?

What is the origin of the vast range of quark and lepton masses in the Standard Model?

- Are there modified interactions to the Higgs boson and known particles?
- Does the Higgs boson decay into pairs of quarks or leptons with distinct flavours (for example, $H \rightarrow \mu^+ \tau^-$)?

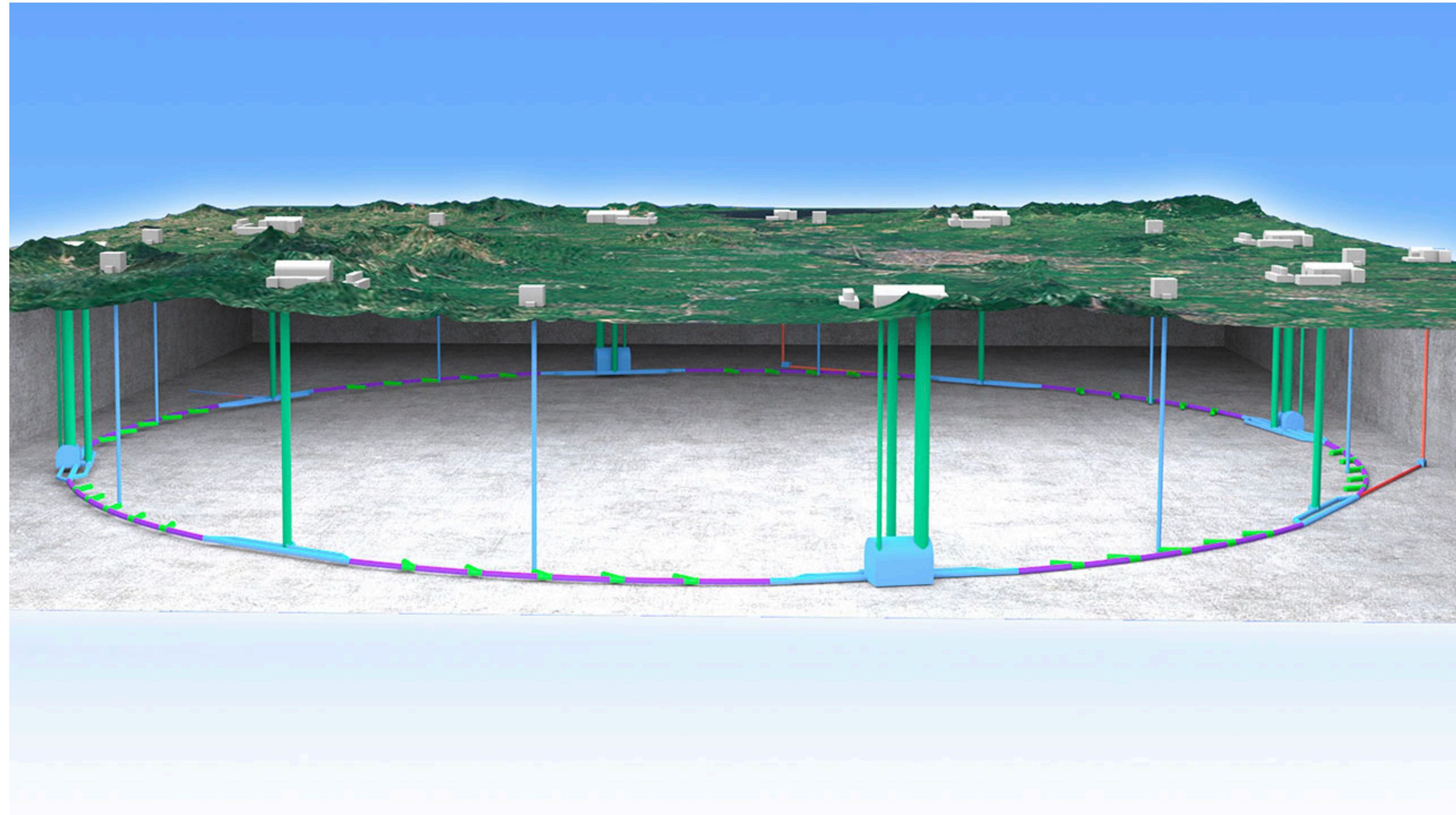
What is the origin of the early Universe inflation?

- Any imprint in cosmological observations?

- Higgs could be the key of major particle physics open problems
- Use the Higgs boson as a new tool for discovery
(Particle Physics Project Prioritization Panel (P5) Strategic Planning 2019)
- Higgs factory is the way to go!

CEPC and its precision approach to new territories

- A Higgs factory running at 240 GeV with e^+e^- collision
- Later it has added Z, WW, $\bar{t}t$ runs to broadening the physics scope
- It is a multi-purpose precision machine



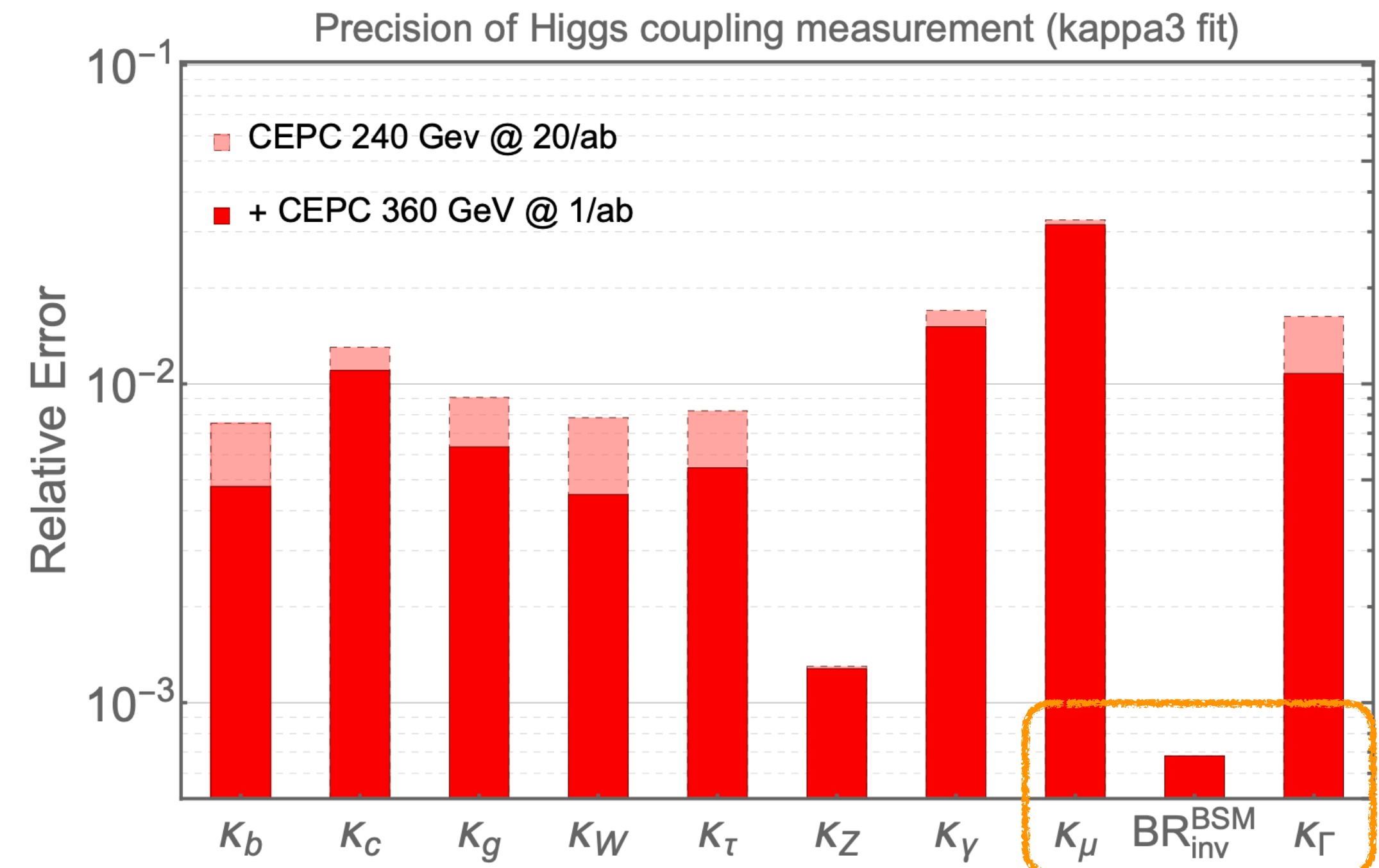
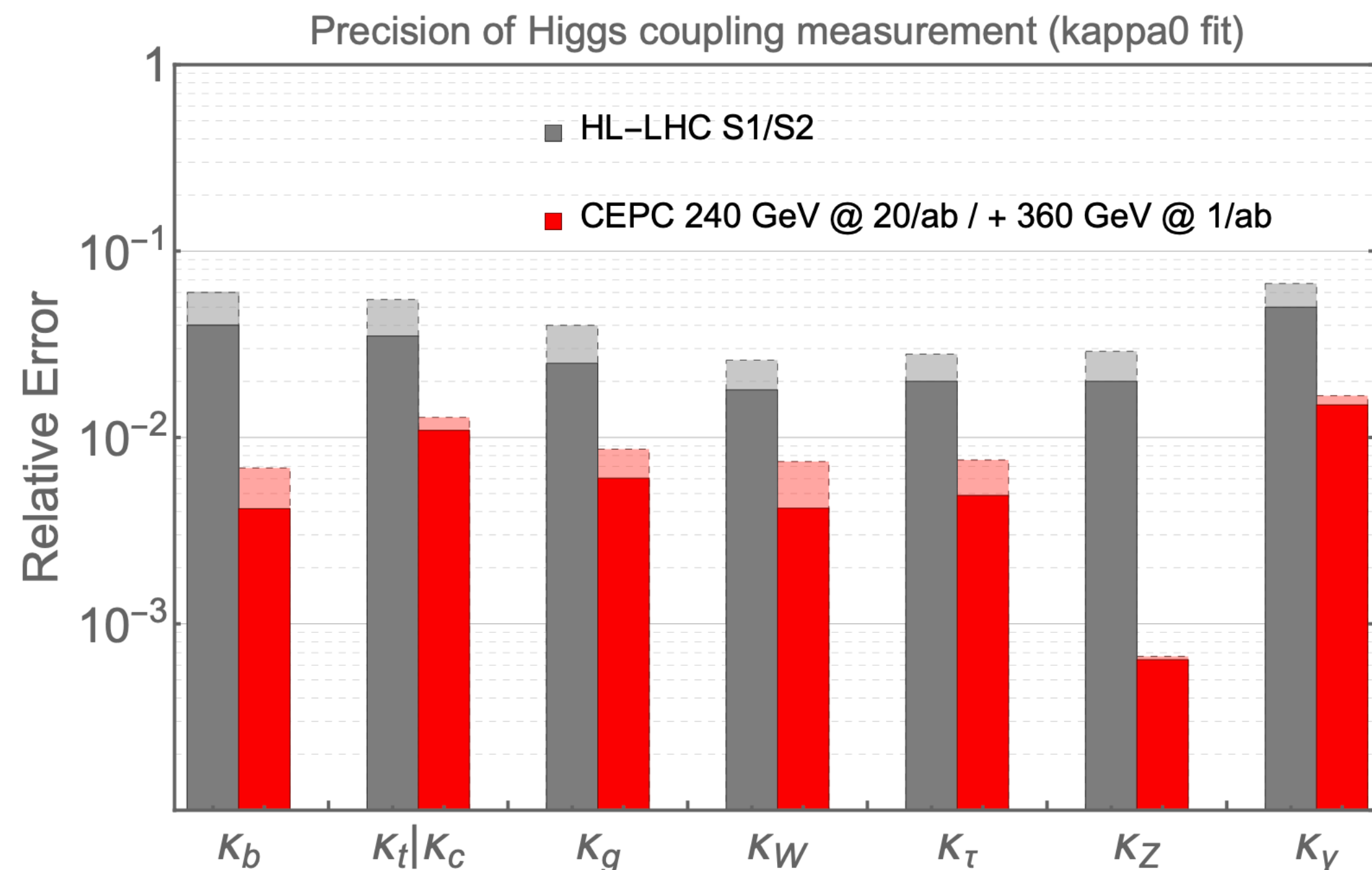
CEPC physics goal

- Precision measurement of Higgs boson (width, couplings, mass, decay channels...)
- Precision test on SM for electroweak, flavor, and QCD physics
- Exotics from H (4M), Z (4T), W (200M) and top (~1M) measurements
- Searching for BSM physics

Operation mode			ZH	Z	W+W-	$t\bar{t}$
$\sqrt{s}$ [GeV]			240	91	160	360
Run time [years]			7	2	1	-
CDR (30 MW)	L / IP [$\times 10^{34}$ cm ⁻² s ⁻¹]		3	32	10	-
	$\int L dt$ [ab ⁻¹ , 2 IPs]		5.6	16	2.6	-
	Event yields [2 IPs]		1×10 ⁶	7×10 ¹¹	2×10 ⁷	-
Run Time [years]			10	2	1	5
TDR (Latest)	30 MW	L / IP [$\times 10^{34}$ cm ⁻² s ⁻¹]	5.0	115	16	0.5
		$\int L dt$ [ab ⁻¹ , 2 IPs]	13	60	4.2	0.65
		Event yields [2 IPs]	2.6×10 ⁶	2.5×10 ¹²	1.3×10 ⁸	4×10 ⁵
	50 MW	L / IP [$\times 10^{34}$ cm ⁻² s ⁻¹]	8.3	192	26.7	0.8
		$\int L dt$ [ab ⁻¹ , 2 IPs]	21.6	100	6.9	1.0
		Event yields [2 IPs]	4.3×10 ⁶	4.1×10 ¹²	2.1×10 ⁸	6×10 ⁵

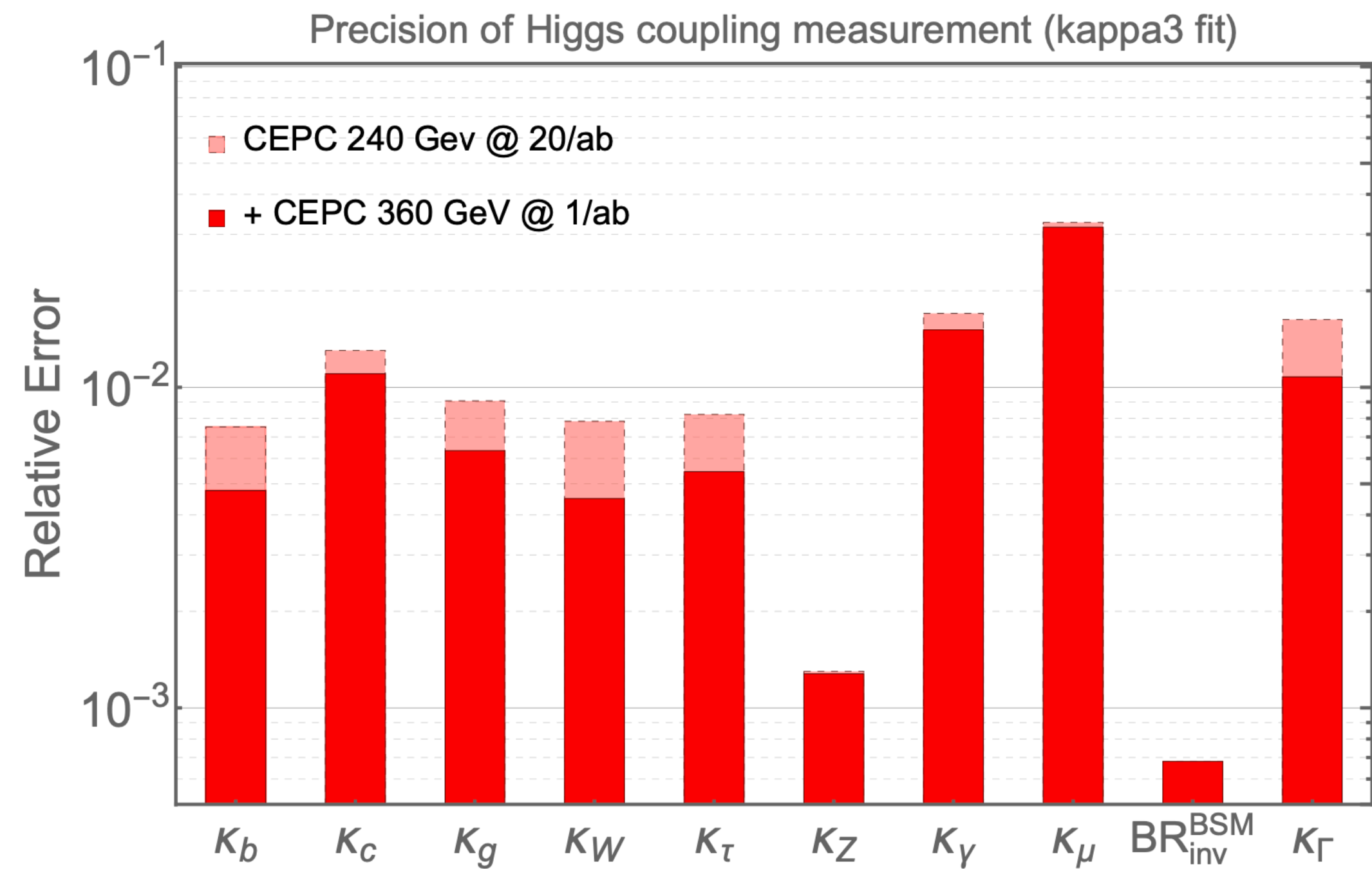
The progress of electroweak studies at CEPC

- Precision Higgs coupling measurement
 - Reaching 0.1%-1% of precision
- Muon coupling, invisible BR and total width measurements



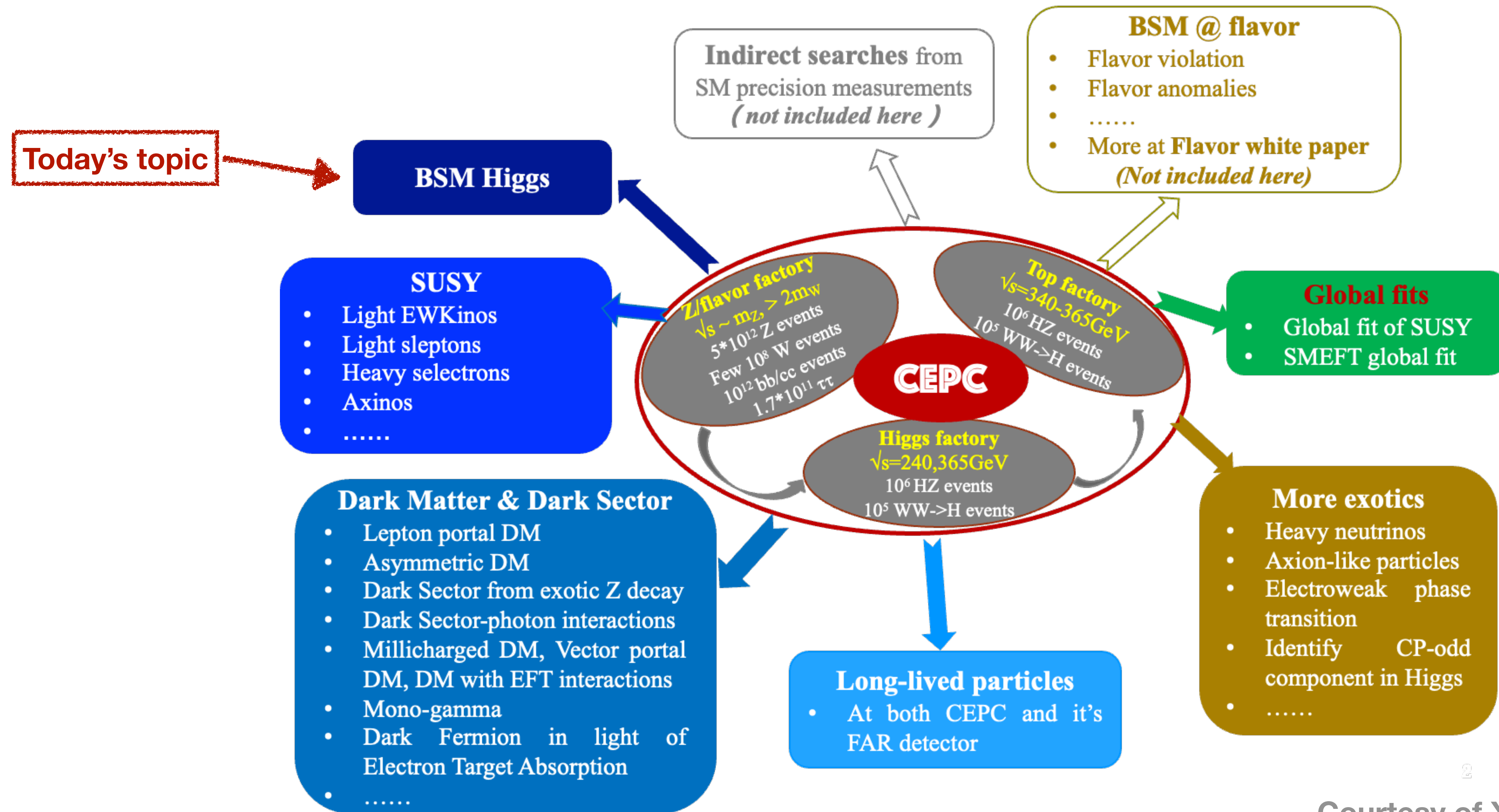
The progress of electroweak studies at CEPC

- Precision Higgs coupling measurement
 - Reaching 0.1 %-1 % of precision
 - Muon coupling, BRs and total width measurements



	240 GeV, 20 ab ⁻¹		360 GeV, 1 ab ⁻¹		
BR	ZH	vvH	ZH	vvH	eeH
inclusive	0.26%		1.40%	\	\
H→bb	0.14%	1.59%	0.90%	1.10%	4.30%
H→cc	2.02%		8.80%	16%	20%
H→gg	0.81%		3.40%	4.50%	12%
H→WW	0.53%		2.80%	4.40%	6.50%
H→ZZ	4.17%		20%	21%	
H→ττ	0.42%		2.10%	4.20%	7.50%
H→γγ	3.02%		11%	16%	
H→μμ	6.36%		41%	57%	
H→Zγ	8.50%		35%		
Br _{upper} (H→inv.)	0.07%				
Γ _H	1.65%		1.10%		

CEPC BSM Physics Program



BSM inputs and status

- BSM Higgs (1709.06103; 1808.02037; 1912.01431; 2008.05492; 2011.04540)
- SUSY Searches
 - Direct SUSY Searches (CPC46(2022)013106; 2101.12131; 2203.10580; 2202.11011, 2211.08132)
 - Indirect search of SUSY (2010.09782)
- Dark Matter and Dark Sector searches
 - Lepton portal DM (JHEP 06 (2021) 149)
 - Asymmetric DM (PRD 104(2021)055008)
 - Dark Sector from exotic Z decay (1712.07237)
 - DM (Millicharged DM, Vector portal DM, DM with EFT interactions): 1903.1211
 - Mono-gamma (2205.05560), Dark Sector-photon interactions (2208.08142)
 - Dark Fermion in light of Electron Target Absorption (2306.00657)
- Long-lived particles (1904.10661, 1911.06576, 2201.08960)
- More exotics:
 - Heavy neutrinos (2102.12826, 2201.05831);
 - Axion-like particles (2103.05218, 2204.04702, 2210.09335, [J. Phys. G](#))
 - Electroweak phase transition (1911.10210, 1911.10206, 2011.04540, 2204.05085)
 - Identify CP-odd component in Higgs study (2212.05390)
 -
- Global fits:
 - Global fit of SUSY (2203.04828, 2203.07883)
 - SMEFT global fit (2206.08326)

Project Schedule

- Objective
 - By the end of December, an initial draft of the NP white paper should be ready, followed by submission for review in January-February 2024.
- Engineering Implementation Steps and Timeline
 - (1) September 2023 - Material Collection:
 - Each session convener should gather relevant materials for their respective sessions:
 - Contact invited article authors for content related to CEPC.
 - Provide a concise half to one-page write-up, following the format: Abstract + Money Plot + Reference.
 - Authors should be informed that some modifications might be made when incorporating the content into the white paper. Their assistance might be required to adapt results for CEPC.
 - Maintain a shared list of invited authors to prevent duplication.
 - (2) Oct 1 - Nov 30 - Session Content Writing (2 months):
 - Session conveners collaborate to consolidate content for each chapter.
 - Strive for a clear and consistent narrative within each chapter, covering Visionary Summary and Benchmark Introduction.
 - Content can be referenced from the CEPC Physics Potential Snowmass Report 2205.08553.
 - Highlight the synergies between CEPC and other experiments: CEPC's discovery power, comparative advantages, and its value in relation to other observation windows and facilities, considering factors like luminosity and detector requirements.
 - Materials can be shared among sessions, each emphasizing its relevance to the chapter's theme without concern for repetition.
 - (3) Dec 1 - Dec 30 - Integration of Session Content (1 month):
 - Led by Liantao, Xuai, Manqi, Zhen, Jia, etc., the integrated content forms the initial draft.
 - (4) Jan-Feb 2024 - Authors review and revise the initial draft, with an ArXiv release by month-end.

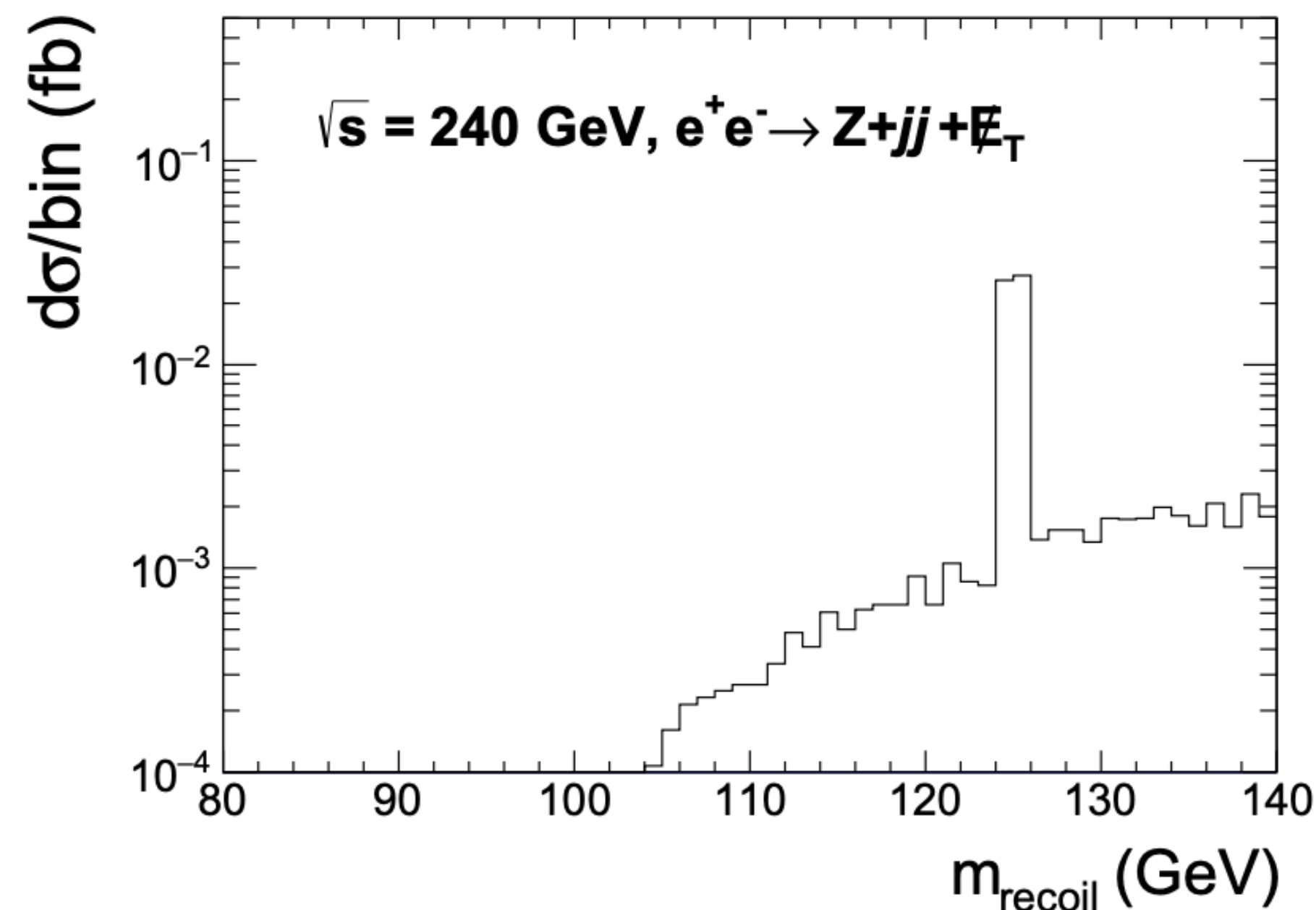
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BSM Higgs studies I: Higgs Exotic Decay

Physics potential of CEPC, 2205.08553 (snowmass 2021)

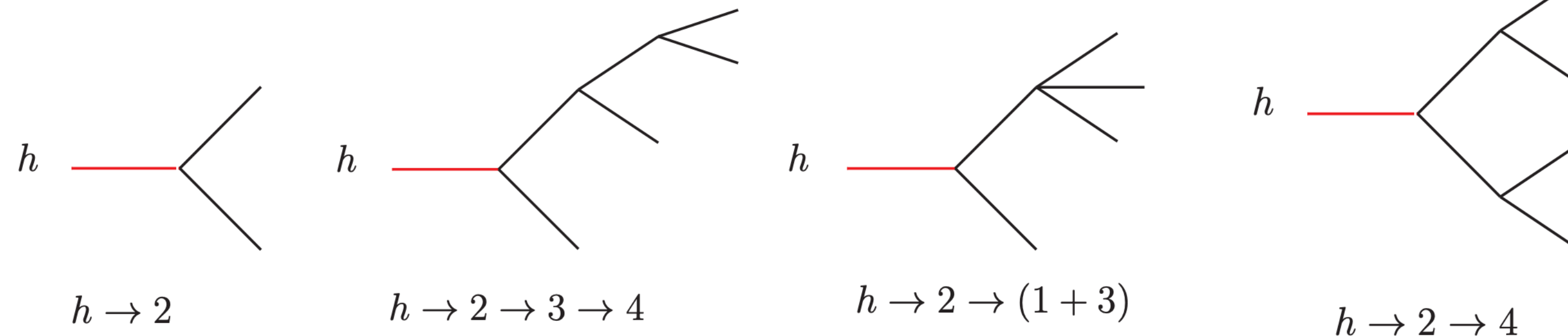
- The Higgs bremsstrahlung production: $e^+e^- \rightarrow hZ, Z \rightarrow \ell^+\ell^-$
 - **CEPC advantage** over LHC: initial state is known
 - Enabling “**recoil mass**” technique: the four-momentum for h is known
 - The partial missing energy final state can be tested at CEPC



BSM Higgs studies I: Higgs Exotic Decay

Physics potential of CEPC, 2205.08553 (snowmass 2021)

- The decay representative topologies: $h \rightarrow X_1 + X_2$

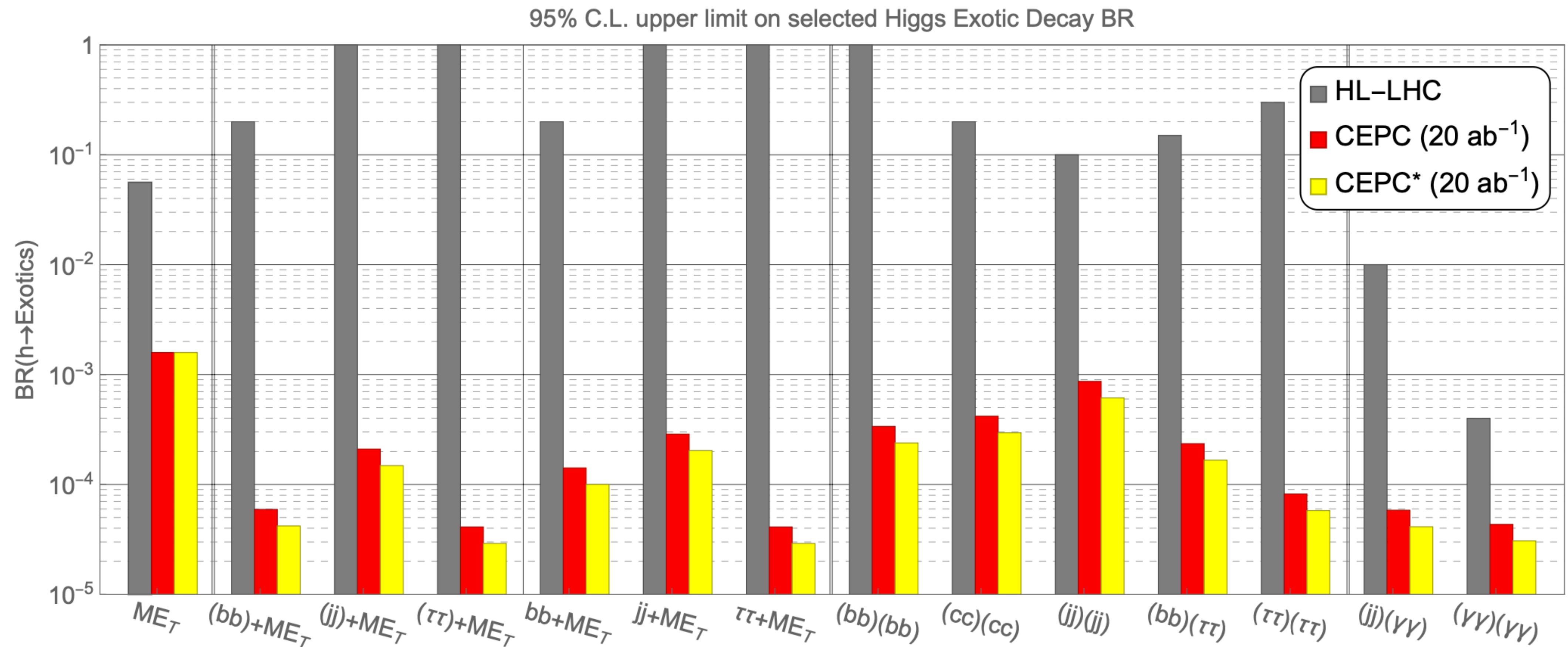


- The particles $X_{1,2}$ maybe detector stable, cascade decay to 2 particles or 3 particles.
- These final state particles can be visible or invisible
 - E.g. from NMSSM: $h \rightarrow \tilde{\chi}_1^0 + \tilde{\chi}_2^0, \tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0 + jj; h \rightarrow jj + \text{MissingE}$
 - E.g. from Singlet Scalar ark sector mediator: $h \rightarrow s + s \rightarrow (jj) + (\chi\chi) \rightarrow (jj) + \text{MissingE}$
 - E.g. from Sterile Neutrino: $h \rightarrow \nu + N, N \rightarrow \nu + jj/\ell^+\ell^-$

BSM Higgs studies I: Higgs Exotic Decay

- CEPC can provide precision test on Higgs exotic decay with production of 4 million Higgs

Physics potential of CEPC, 2205.08553 (snowmass 2021)



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BSM Higgs studies II: Exotic Light Higgs Search

- Before SM Higgs discovery, LEP searched light Higgs for SM
- CEPC should continue this task at higher luminosity and precision:
 - **CEPC Advantage:** LHC is not good due to large QCD BKG at lower E regions
- Extra light singlet or Doublet (neutral) Higgs models are common in BSM

- The scalar potential for 2HDM + Singlet Scalar model
- Possible light elements:
CP-even: H_0, s_1
CP-odd : A_0, s_2
- The extension of Higgs potential can lead to Strong First Order Phase Transition (SFOPT)

$$\begin{aligned} V(H_1, H_2, S) = & m_{11}^2 H_1^\dagger H_1 + m_{22}^2 H_2^\dagger H_2 \\ & - \mu^2 \left(H_1^\dagger H_2 + H_2^\dagger H_1 \right) + \frac{1}{2} m_S^2 S^2 \\ & + \frac{\lambda_1}{2} \left(H_1^\dagger H_1 \right)^2 + \frac{\lambda_2}{2} \left(H_2^\dagger H_2 \right)^2 \\ & + \lambda_3 H_1^\dagger H_1 H_2^\dagger H_2 + \lambda_4 H_1^\dagger H_2 H_2^\dagger H_1 \\ & + \frac{\lambda_5}{2} \left[\left(H_1^\dagger H_2 \right)^2 + \left(H_2^\dagger H_1 \right)^2 \right] \\ & + \frac{\lambda_6}{8} S^4 + \frac{1}{2} [\lambda_7 H_1^\dagger H_1 + \lambda_8 H_2^\dagger H_2] S^2 \end{aligned}$$

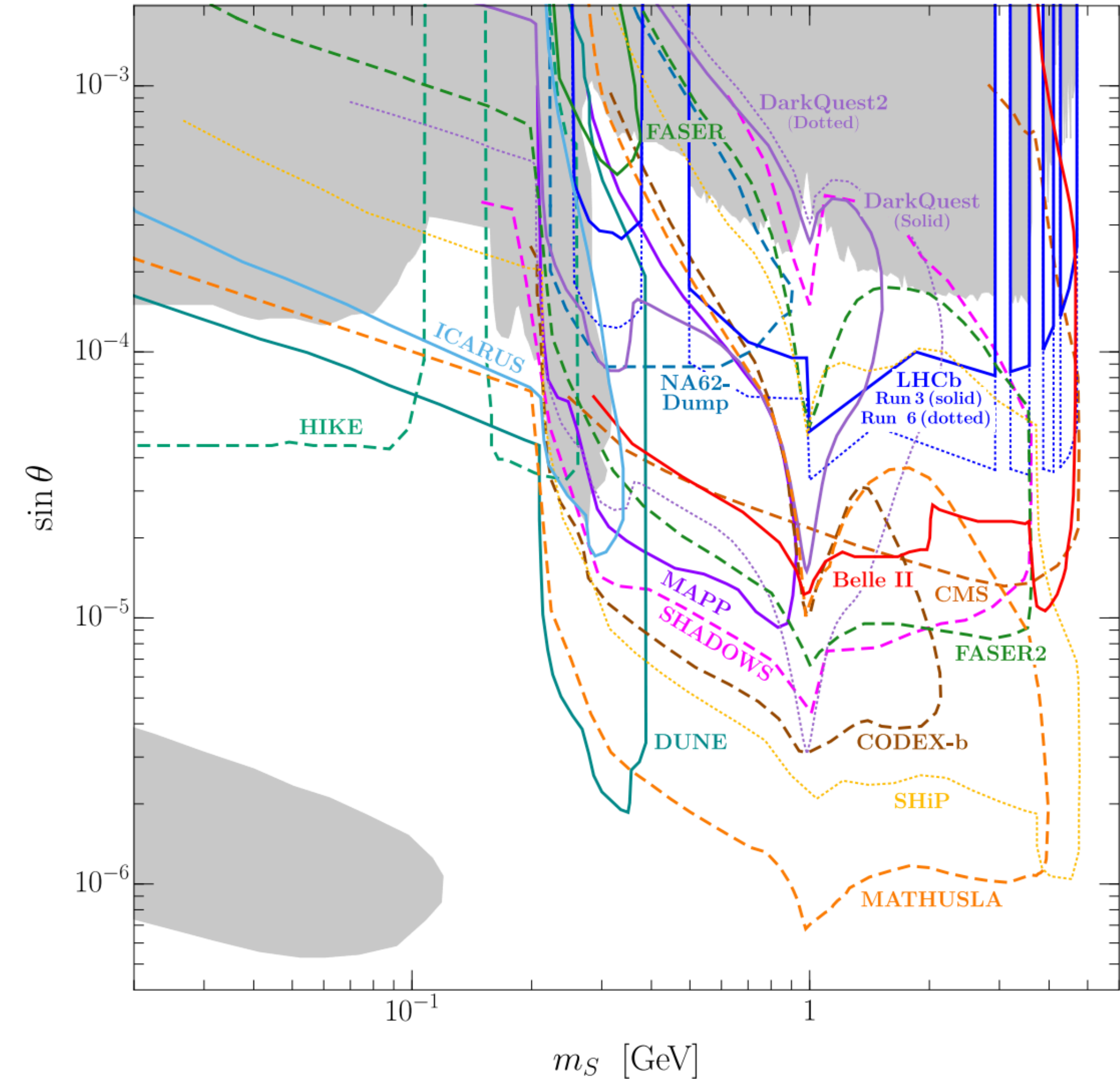
BSM Higgs studies II: Exotic Light Higgs Search

- The vanilla targets for light Higgs (Higgs Portal)

- $-\mathcal{L} \supset (AS + \lambda S^2) H^\dagger H$

- S-h mixing angle θ : $\sin \theta \frac{m_f}{v} S f \bar{f}$

- **Two parameters:** $m_S, \sin \theta$



BSM Higgs studies II: Exotic Light Higgs Search

- More Baroque setup is possible
- Different mixing angles to different fermions

$$\epsilon_q \approx \epsilon_W$$

$$\mathcal{L}_{\text{eff}} \supset \sum_q \epsilon_q \frac{m_q}{v} \phi \bar{q} q + \sum_\ell \epsilon_\ell \frac{m_\ell}{v} \phi \bar{\ell} \ell + \epsilon_W \frac{2m_W^2}{v} \phi W_\mu^+ W^{\mu-}.$$

- Type-X 2HDM + Singlet

$$\mathcal{L}_{\text{yuk}} = -\lambda_u \bar{Q} \tilde{\Phi}_2 u_R - \lambda_d \bar{Q} \Phi_2 d_R - \lambda_e \bar{L} \Phi_1 e_R + h.c.,$$

$$\begin{pmatrix} \sqrt{2} \text{Re} [\Phi_1^0] \\ \sqrt{2} \text{Re} [\Phi_2^0] \\ \phi_0 \end{pmatrix} \simeq \begin{pmatrix} \cos \alpha & -\sin \alpha & \sin \theta_{1\phi} \\ \sin \alpha & \cos \alpha & \sin \theta_{2\phi} \\ -\sin \theta_{1\phi} & -\sin \theta_{2\phi} & 1 \end{pmatrix} \cdot \begin{pmatrix} H \\ h \\ \phi \end{pmatrix}$$

$$\epsilon_q \simeq \frac{\sin \theta_{2\phi}}{\sin \beta}, \quad \epsilon_\ell \simeq \frac{\sin \theta_{1\phi}}{\cos \beta}.$$

$$\epsilon_W \simeq (\sin \theta_{1\phi} \cos \beta + \sin \theta_{2\phi} \sin \beta)$$

$$\approx \epsilon_\ell \cos^2 \beta + \epsilon_q \sin^2 \beta \approx \epsilon_q,$$

BSM Higgs studies II: Exotic Light Higgs Search

- The Fermion portal to Dark Sector
- The Interaction: $\lambda \bar{\psi} \phi f_{\text{SM}}$
- Dark Scalars in the Dark Sector
 - Fermion portal — quark/lepton portal
 - f can be quark/lepton, L/R-handed

	DM	SM char	Z ₂
ψ	Yes	No	-1
ϕ	No	Yes	-1
f_{SM}	No	Yes	1

JL, S. Brian, N. Weiner, I. Yavin, 1303.4404 (JHEP)
 Y. Bai, J. Berger, 1308.0612 (JHEP)

- Coupling to specific flavor

$$\mathcal{L} \supset -g_u S \bar{u} u - g_\chi S \bar{\chi} \chi,$$

UV completed by Vector-like Fermions

$$\begin{aligned} \mathcal{L}_{\text{VLQ}} = \mathcal{L}_{\text{SM}} &+ \frac{1}{2} \partial_\mu S \partial^\mu S - \frac{1}{2} m_S^2 S^2 + \bar{U}' i \gamma^\mu D_\mu U' - M \bar{U}' U' \\ &- [y_i \bar{Q}_L^i U_R' H_c + \lambda^i \bar{U}_L' u_{Ri} S + \text{h.c.}] \end{aligned}$$



Higher Dimensional EFT

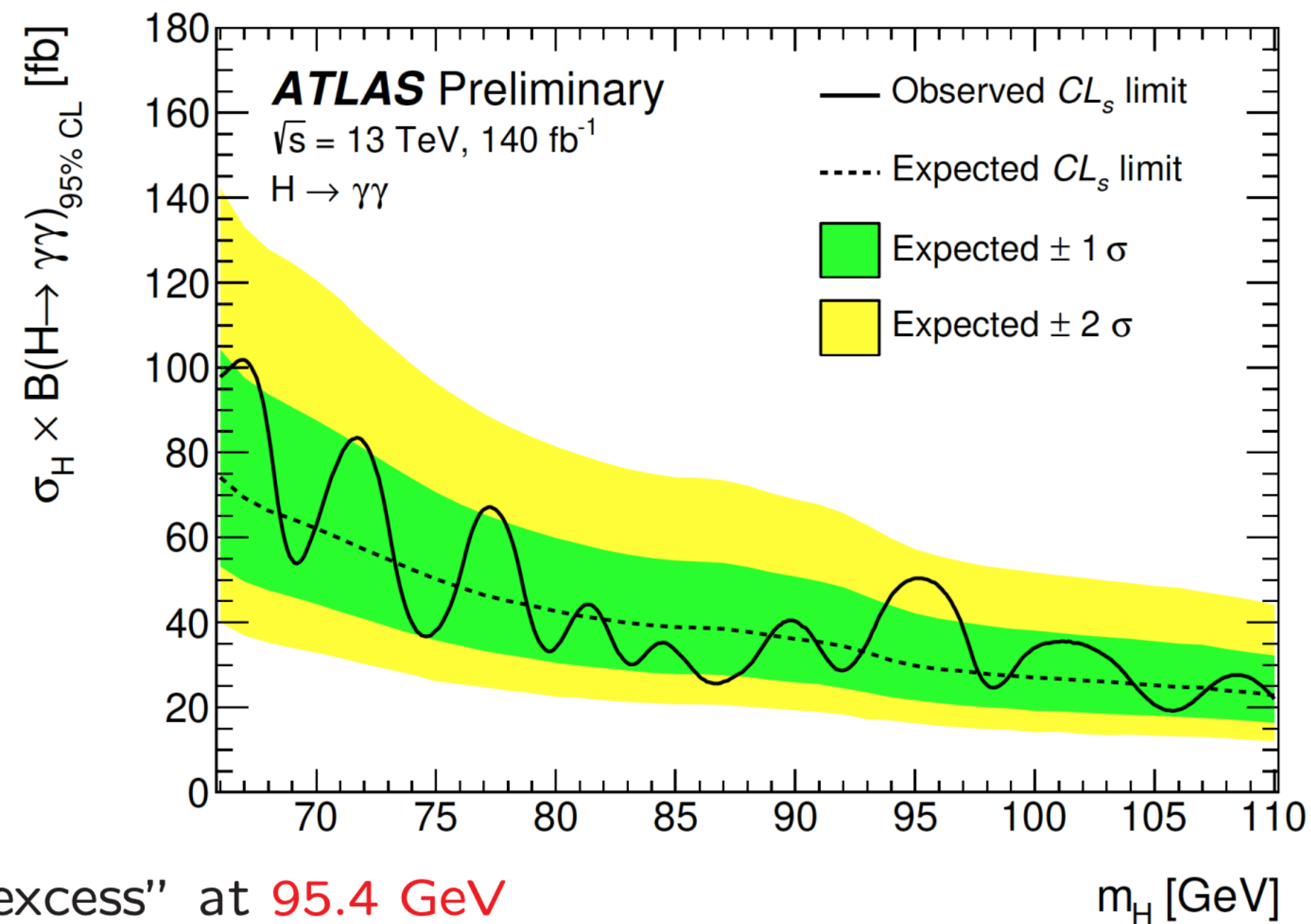
$$\mathcal{L} \supset \frac{y_i \lambda^j}{M} S \bar{Q}_L^i u_{Rj} H_c + \text{h.c.}$$

Batell et al, 2107.08059

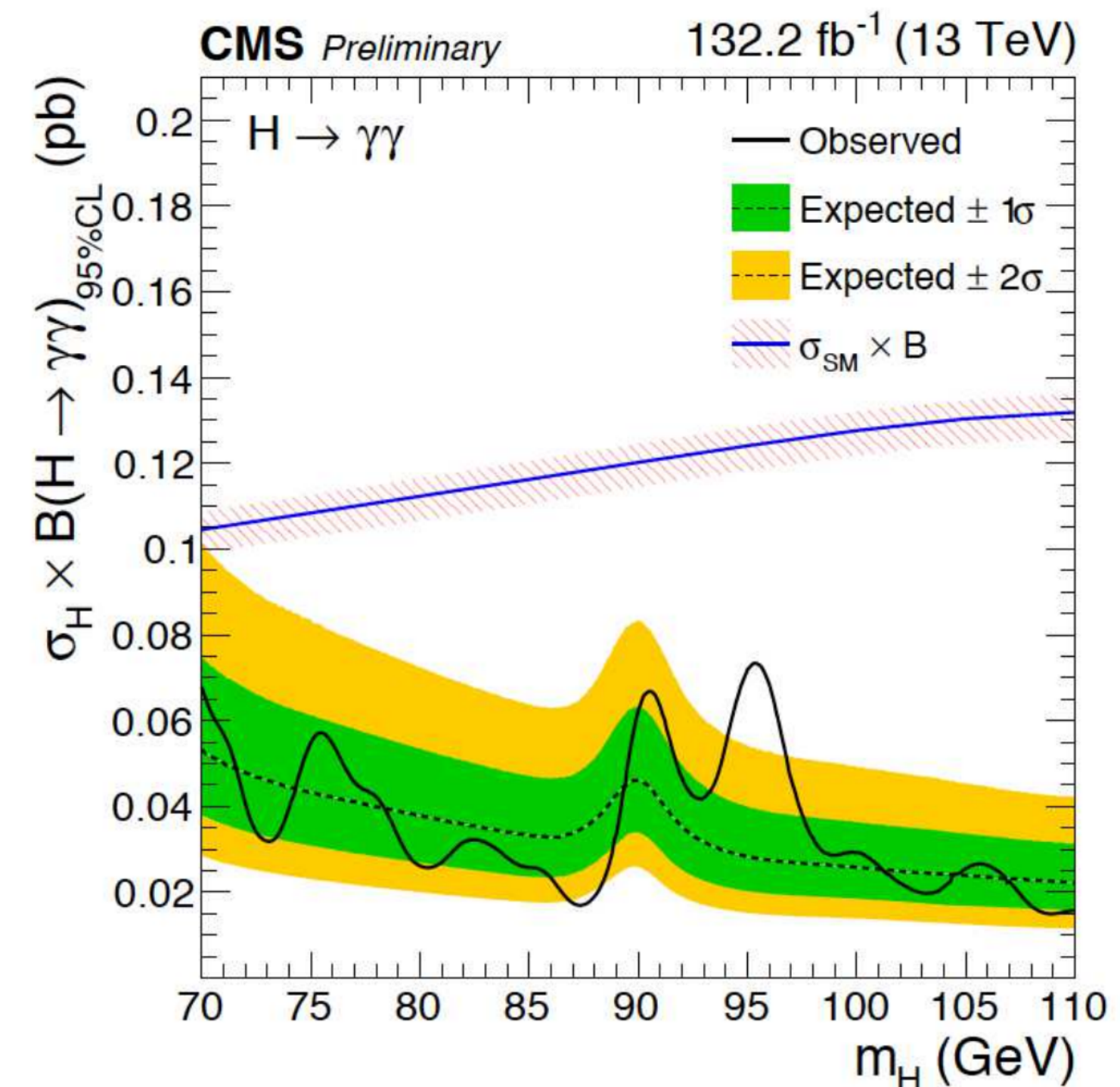
BSM Higgs studies II: Exotic Light Higgs Search

- An interesting interlude from LHC low mass Higgs studies (96 GeV)

New ATLAS result on the low-mass Higgs search in $pp \rightarrow \phi \rightarrow \gamma\gamma$



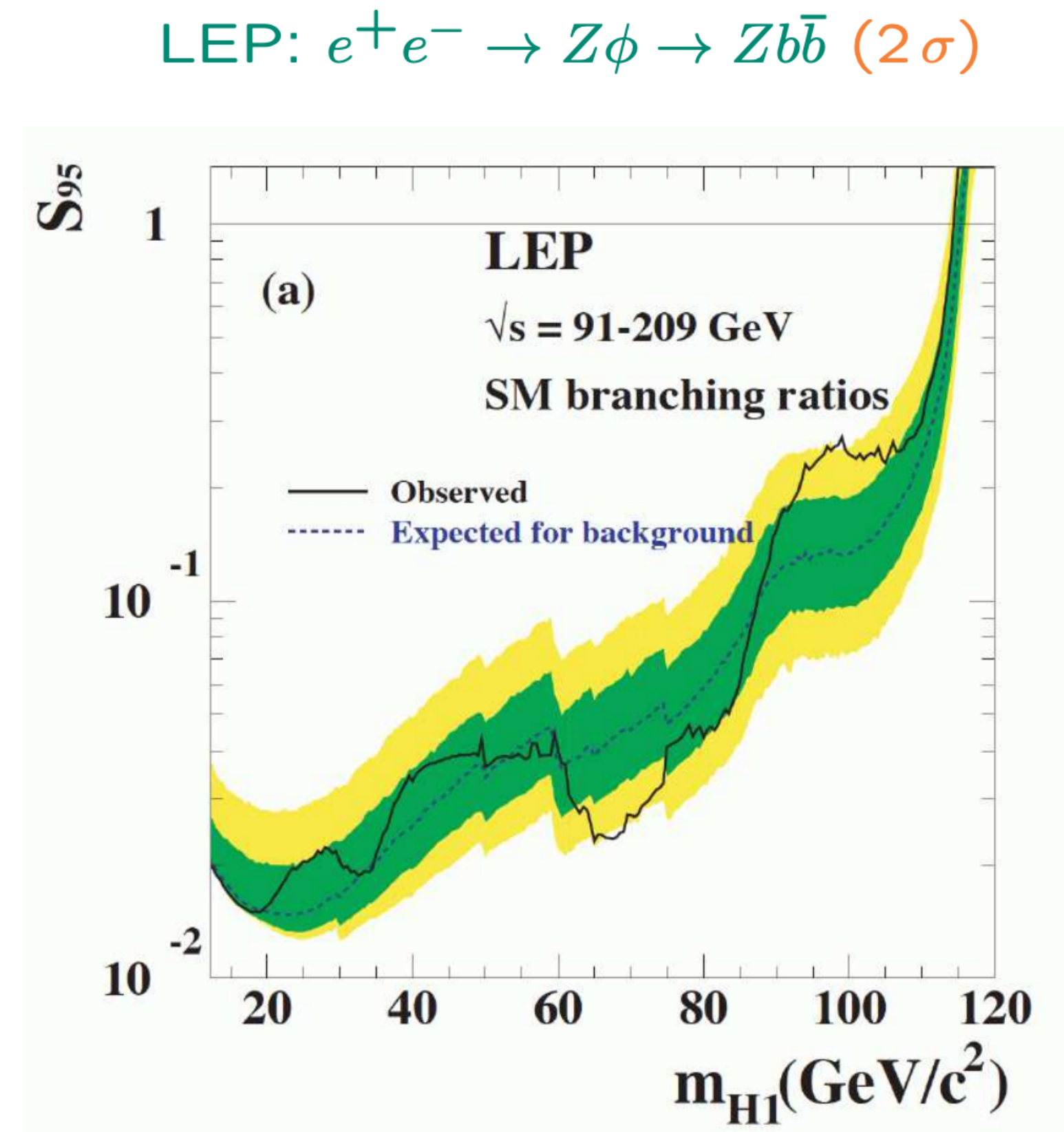
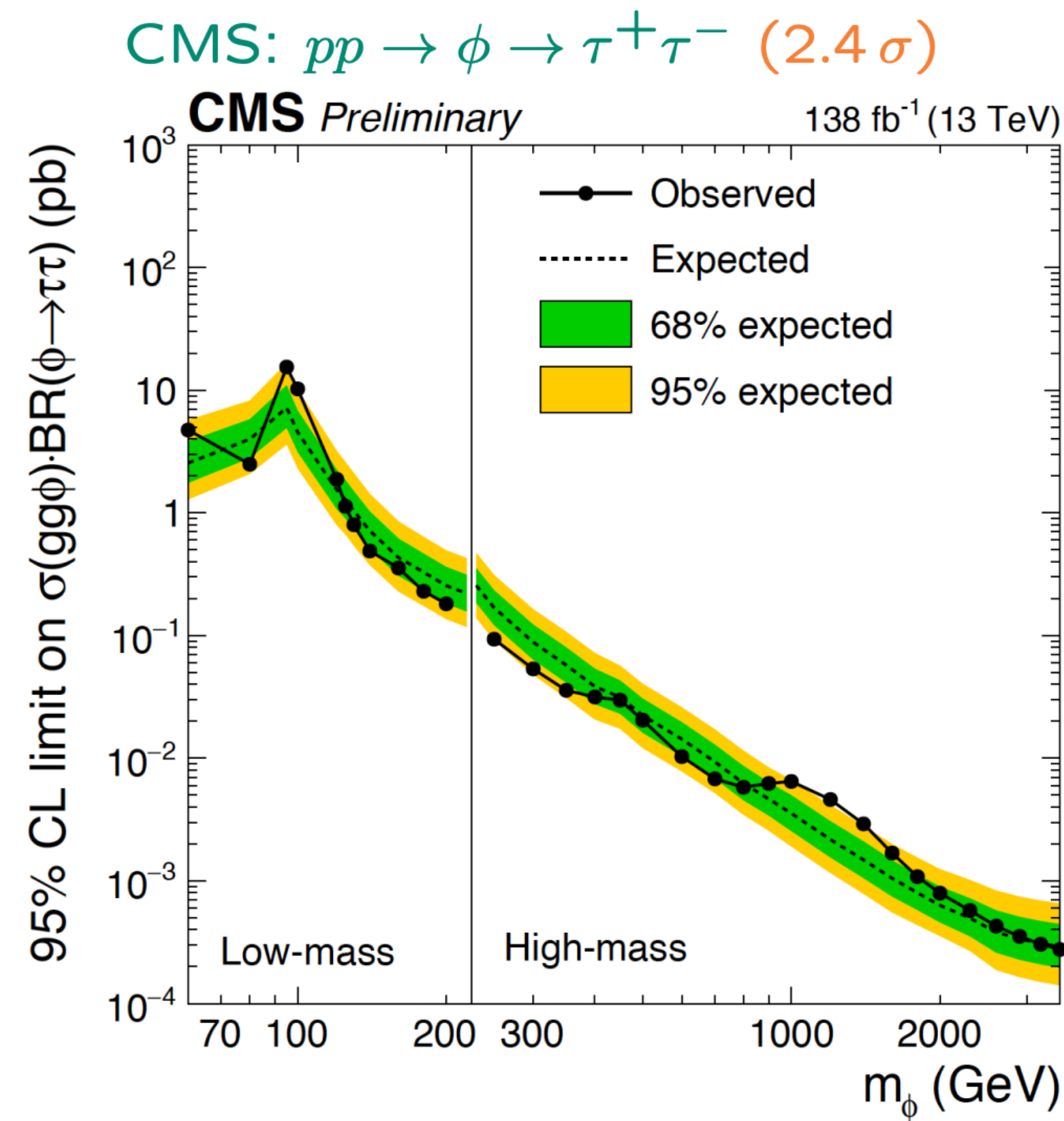
⇒ highest “excess” at **95.4 GeV**



Courtesy of Sven Heinemeyer, PPC2023

BSM Higgs studies II: Exotic Light Higgs Search

- An interesting interlude from LHC low mass Higgs studies (96 GeV)



- Agreement between ATLAS/CMS (S. Heinemeyer 23'), stay tuned

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BSM Higgs studies II: DS Scalars at the Z-factory

- Kinetic Mixing Portal: A' should kinetic mixing with Hypercharge field

$$\mathcal{L} = -\frac{1}{4}F'_{\mu\nu}F'^{\mu\nu} + \frac{1}{2}m_{A'}^2 A'^{\mu}A'_{\mu} - \frac{1}{2}\epsilon F'_{\mu\nu}B^{\mu\nu} + g'A'_{\mu}j_D^{\mu}$$

- Z gauge boson is involved (K denotes A')

$$\mathcal{L} \supset \frac{-1}{4} \begin{pmatrix} Z_{\text{SM}}^{\mu\nu} & A_{\text{SM}}^{\mu\nu} & K^{\mu\nu} \end{pmatrix} \begin{pmatrix} 1 & 0 & \epsilon t_W \\ 0 & 1 & -\epsilon \\ \epsilon t_W & -\epsilon & 1 \end{pmatrix} \begin{pmatrix} Z_{\mu\nu, \text{SM}} \\ A_{\mu\nu, \text{SM}} \\ K_{\mu\nu} \end{pmatrix} \\ + \frac{1}{2} \begin{pmatrix} Z_{\text{SM}}^{\mu} & A_{\text{SM}}^{\mu} & K^{\mu} \end{pmatrix} \begin{pmatrix} m_{Z, \text{SM}}^2 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & m_K^2 \end{pmatrix} \begin{pmatrix} Z_{\mu, \text{SM}} \\ A_{\mu, \text{SM}} \\ K_{\mu} \end{pmatrix},$$

BSM Higgs studies II: DS Scalars at the Z-factory

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- After normalizing kinetic terms and diagonalizing 3x3 mass matrix

$$\begin{aligned}\mathcal{L} &\supset gZ_{\mu, \text{SM}}J_Z^{\mu} + eA_{\mu, \text{SM}}J_{\text{em}}^{\mu} + g_D K_{\mu}J_D^{\mu} \\ &= \tilde{Z}_{\mu} \left(gJ_Z^{\mu} - g_D \frac{m_{Z, \text{SM}}^2 t_W}{m_{Z, \text{SM}}^2 - m_K^2} \epsilon J_D^{\mu} + g \frac{m_{Z, \text{SM}}^2 (m_{Z, \text{SM}}^2 - 2m_K^2) t_W^2}{2(m_K^2 - m_{Z, \text{SM}}^2)^2} \epsilon^2 J_Z^{\mu} - e \frac{m_{Z, \text{SM}}^2 t_W}{m_{Z, \text{SM}}^2 - m_K^2} \epsilon^2 J_{\text{em}}^{\mu} \right) \\ &+ \tilde{K}_{\mu} \left(g_D J_D^{\mu} + g \frac{m_K^2 t_W}{m_{Z, \text{SM}}^2 - m_K^2} \epsilon J_Z^{\mu} + e \epsilon J_{\text{em}}^{\mu} + g_D \frac{(m_{Z, \text{SM}}^4 c_W^2 - 2m_K^2 m_{Z, \text{SM}}^2 + m_K^4) c_W^{-2}}{2(m_{Z, \text{SM}}^2 - m_K^2)^2} \epsilon^2 J_D^{\mu} \right) \\ &+ \tilde{A}_{\mu} e J_{\text{em}}^{\mu}.\end{aligned}$$

Vanish in the $m_{A'} \ll m_Z$ limit

BSM Higgs studies II: DS Scalars at the Z-factory

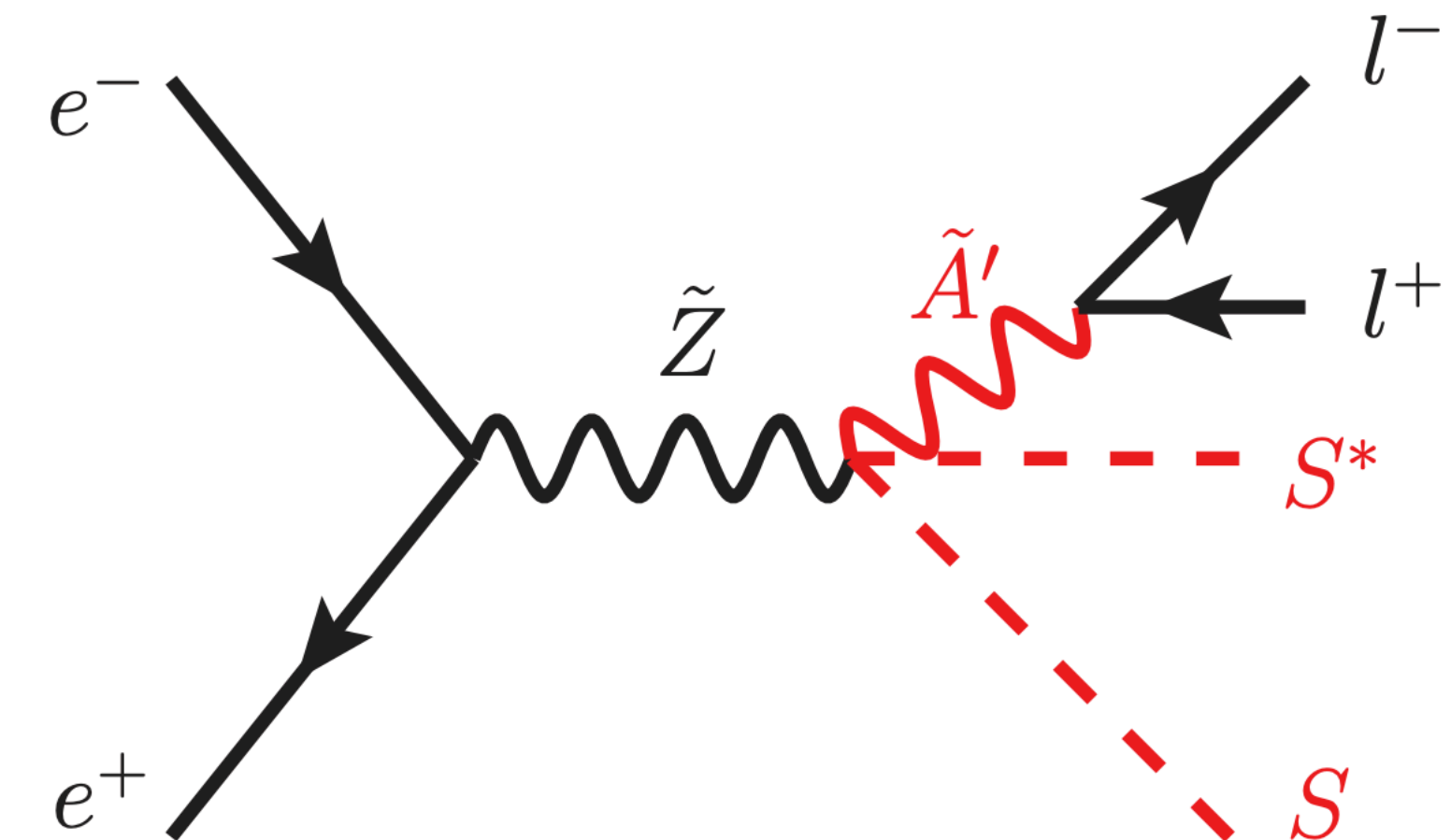
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- After normalizing kinetic terms and diagonalizing 3x3 mass matrix

Exist but usually overlooked
Could be tested at future Z-factory (e.g. CEPC)

$$\begin{aligned} \mathcal{L} \supset & gZ_{\mu, \text{SM}}J_Z^{\mu} + eA_{\mu, \text{SM}}J_{\text{em}}^{\mu} + g_D K_{\mu}J_D^{\mu} \\ = & \tilde{Z}_{\mu} \left(gJ_Z^{\mu} - g_D \frac{m_{Z, \text{SM}}^2 t_W}{m_{Z, \text{SM}}^2 - m_K^2} \epsilon J_D^{\mu} + g \frac{m_{Z, \text{SM}}^2 (m_{Z, \text{SM}}^2 - m_K^2)}{2(m_K^2 - m_{Z, \text{SM}}^2)} \right. \\ & + \tilde{K}_{\mu} \left(g_D J_D^{\mu} + g \frac{m_K^2 t_W}{m_{Z, \text{SM}}^2 - m_K^2} \epsilon J_Z^{\mu} + e \epsilon J_{\text{em}}^{\mu} + g_D \frac{(m_{Z, \text{SM}}^4)}{m_{Z, \text{SM}}^2 - m_K^2} \right. \\ & \left. + \tilde{A}_{\mu} e J_{\text{em}}^{\mu} \right. \end{aligned}$$



E.g. if dark scalar is contained in the current j_D

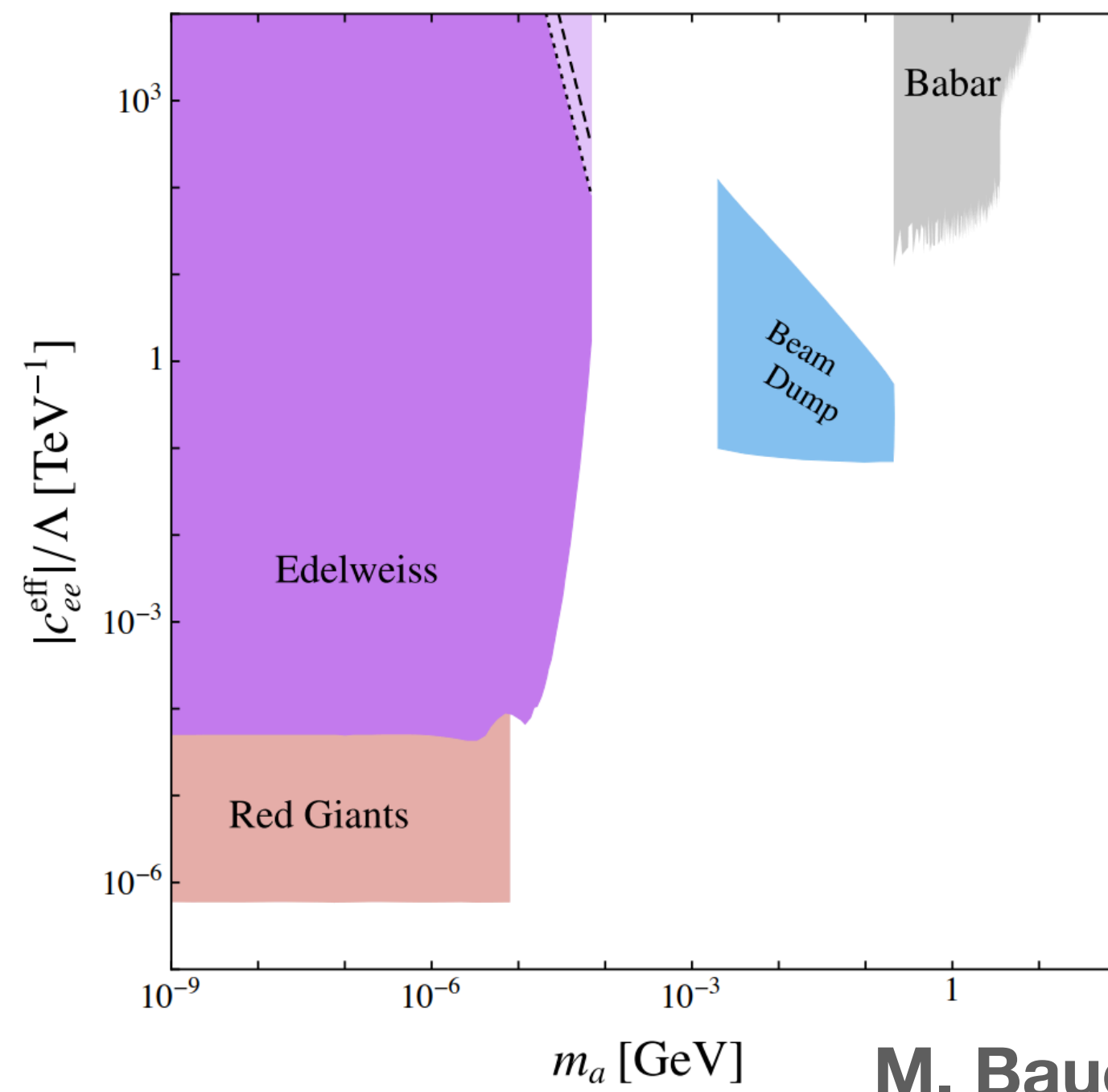
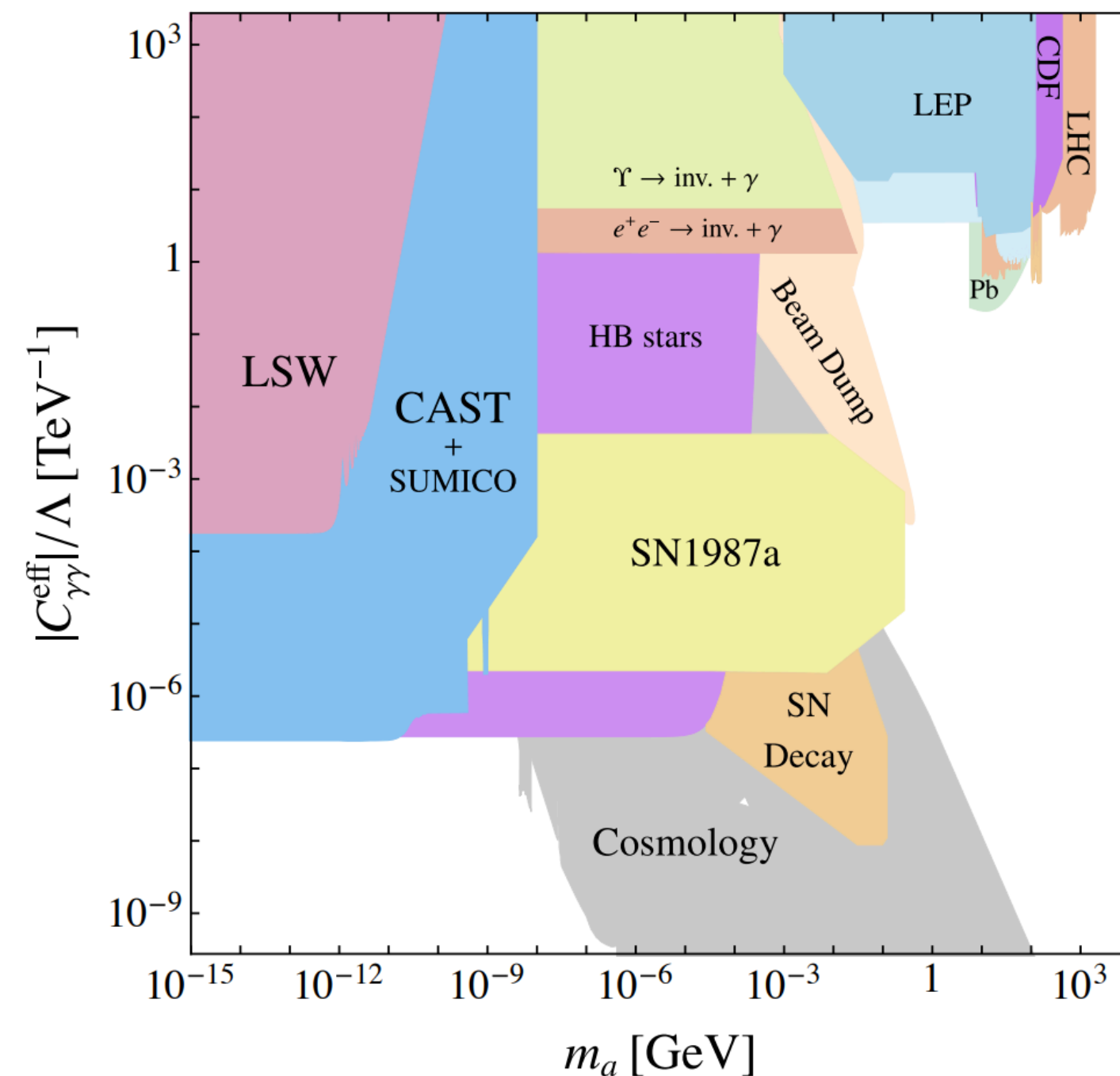
BSM Higgs studies II: DS Pseudo-Scalars at the Z-factory

- The general Axion/ALPs Lagrangian

$$\mathcal{L}_{\text{eff}}^{D \leq 5} = \frac{1}{2} (\partial_\mu a)(\partial^\mu a) - \frac{m_{a,0}^2}{2} a^2 + \frac{\partial^\mu a}{\Lambda} \sum_F \bar{\psi}_F \mathbf{C}_F \gamma_\mu \psi_F$$

$$+ g_s^2 C_{GG} \frac{a}{\Lambda} G_{\mu\nu}^A \tilde{G}^{\mu\nu,A} + g^2 C_{WW} \frac{a}{\Lambda} W_{\mu\nu}^A \tilde{W}^{\mu\nu,A} + g'^2 C_{BB} \frac{a}{\Lambda} B_{\mu\nu} \tilde{B}^{\mu\nu}$$

- Motivates searches at colliders and beam dump searches



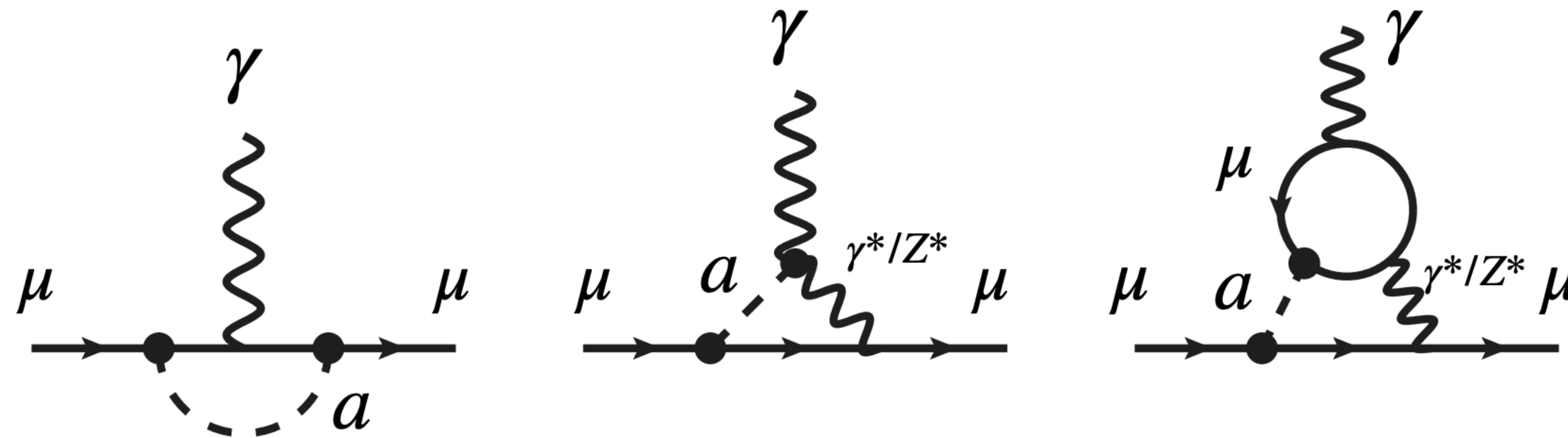
BSM Higgs studies III: DS Pseudo-Scalars at the Z-factory

- A pseudo-scalar connection to muon g-2

$$\mathcal{L}_{\text{eff}}^{D \leq 5} = \frac{1}{2} (\partial_\mu a)(\partial^\mu a) - \frac{m_{a,0}^2}{2} a^2 + \frac{\partial^\mu a}{\Lambda} \sum_F \bar{\psi}_F \mathbf{C}_F \gamma_\mu \psi_F$$

$$+ g_s^2 C_{GG} \frac{a}{\Lambda} G_{\mu\nu}^A \tilde{G}^{\mu\nu,A} + g^2 C_{WW} \frac{a}{\Lambda} W_{\mu\nu}^A \tilde{W}^{\mu\nu,A} + g'^2 C_{BB} \frac{a}{\Lambda} B_{\mu\nu} \tilde{B}^{\mu\nu}$$

- Couplings to muon, Hypercharge field B, and SU(2) W



W.Y. Keung et al, hep-ph/0009292

W.J. Marciano et al. 1607.01022

M. Bauer, M. Neubert, A. Thamm, 1708.00443

M. A. Buen-Abad, J. Fan, M. Reece, C. Sun 2104.03267

JL, X. Ma, L.T. Wang, W.P. Wang 2210.09335 (PRD)

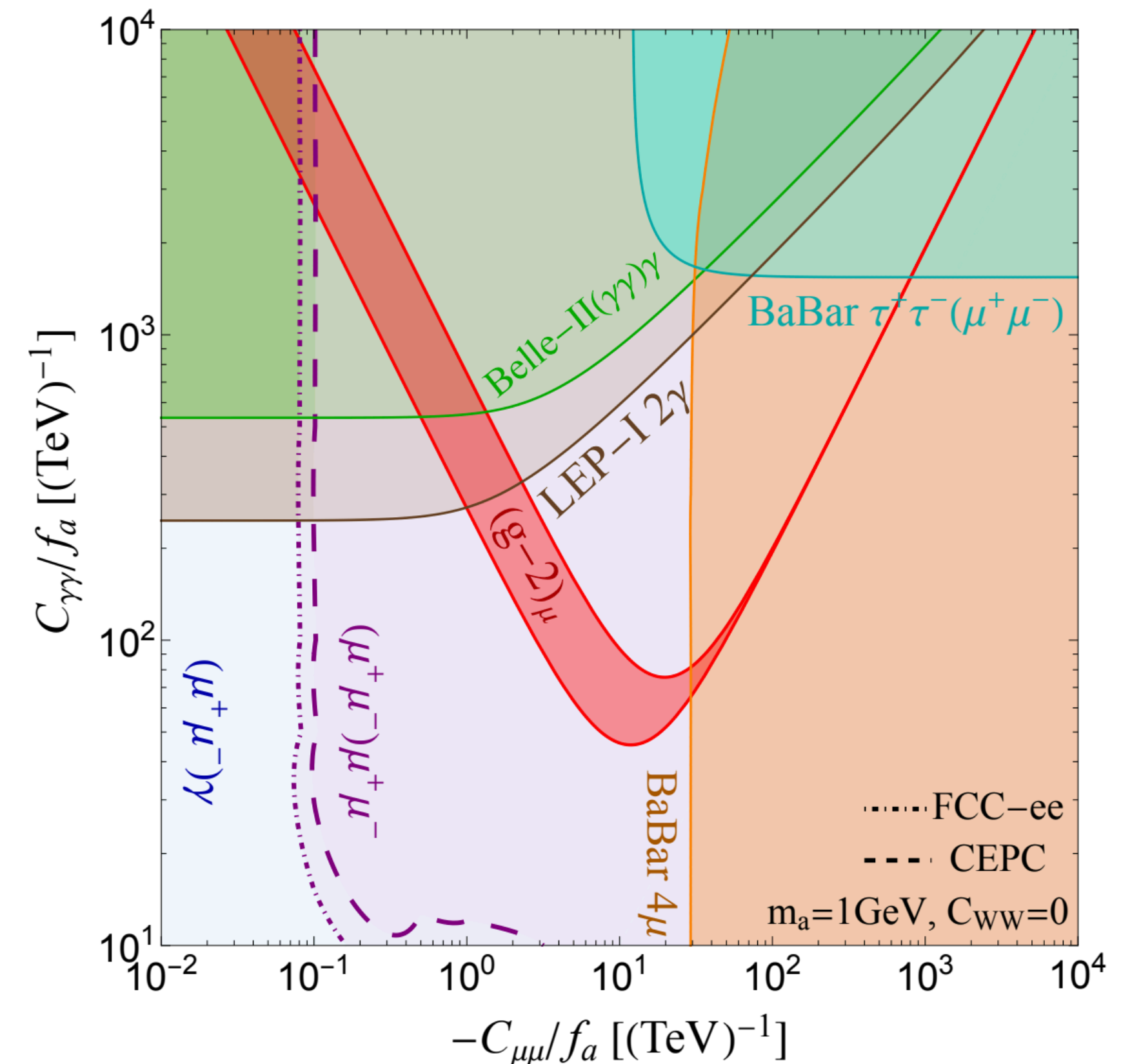
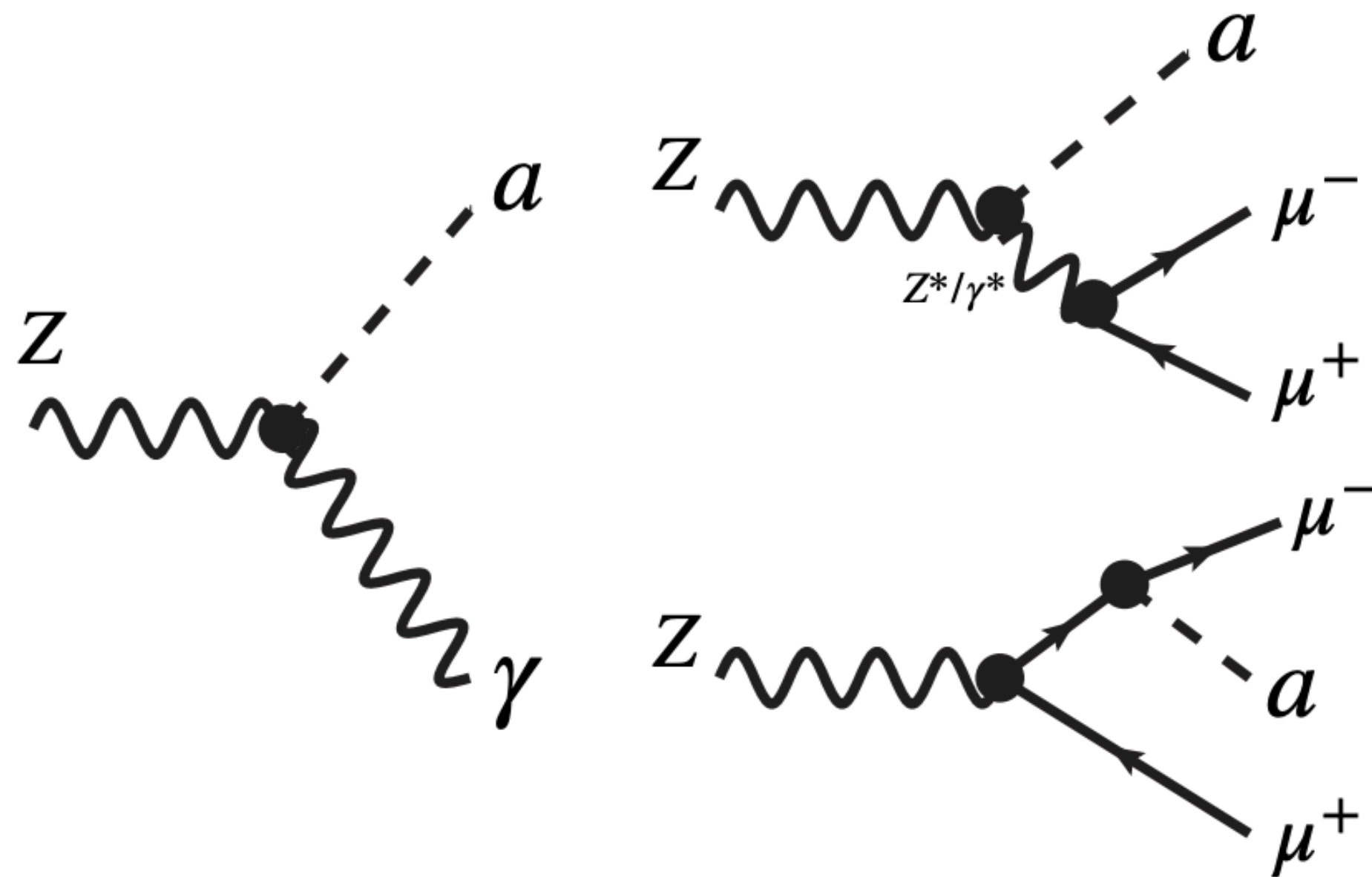
BSM Higgs studies III: DS Pseudo-Scalars at the Z-factory

- A pseudo-scalar connection to muon g-2 and future Z-factory

$$\mathcal{L}_{\text{eff}}^{D \leq 5} = \frac{1}{2} (\partial_\mu a)(\partial^\mu a) - \frac{m_{a,0}^2}{2} a^2 + \frac{\partial^\mu a}{\Lambda} \sum_F \bar{\psi}_F \mathbf{C}_F \gamma_\mu \psi_F$$

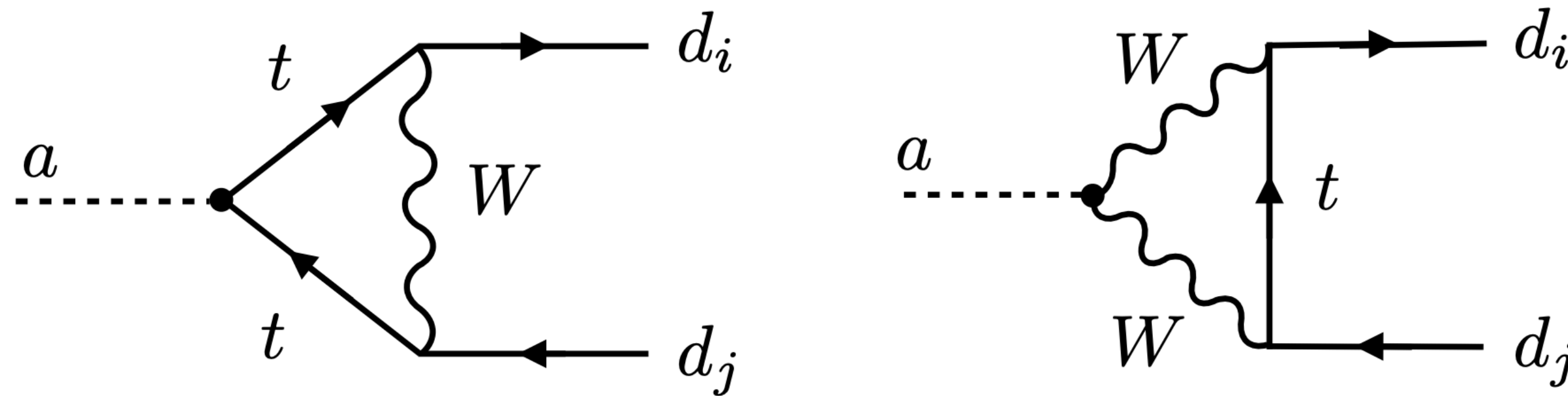
$$+ g_s^2 C_{GG} \frac{a}{\Lambda} G_{\mu\nu}^A \tilde{G}^{\mu\nu,A} + g^2 C_{WW} \frac{a}{\Lambda} W_{\mu\nu}^A \tilde{W}^{\mu\nu,A} + g'^2 C_{BB} \frac{a}{\Lambda} B_{\mu\nu} \tilde{B}^{\mu\nu}$$

- Z exotic decays

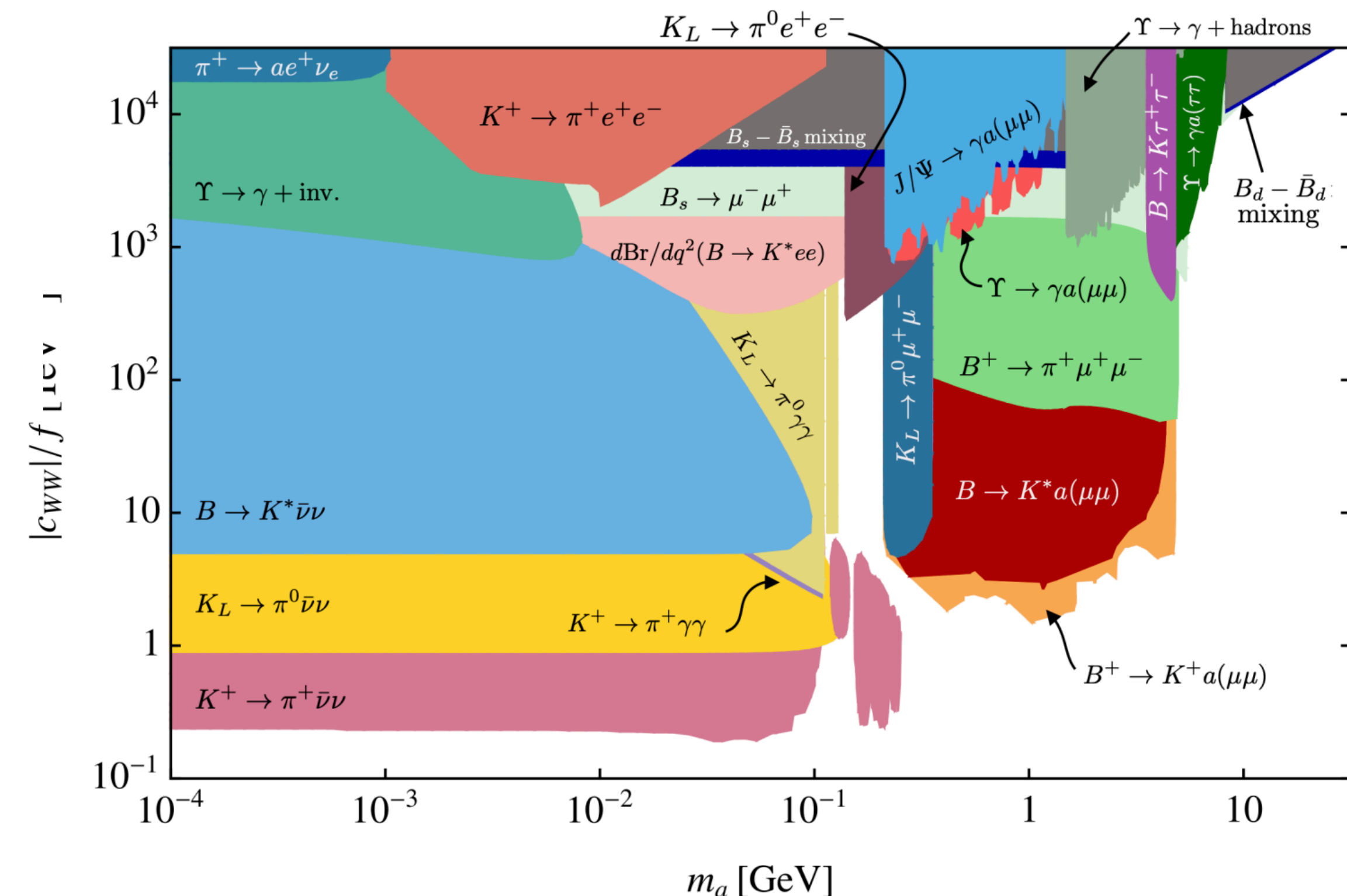


BSM Higgs studies III: DS Pseudo-Scalars at CEPC

- The general Lagrangian (usually people consider flavor diagonal)
- However, if starting from high energy, it will end up with flavor off-diagonal interactions at low energy: $\mathbf{C}_F \rightarrow \mathbf{C}_F^{ij}$



- Providing ALP motivations to Flavor Searches at low energy, e.g. BES-III, Belle-II, STCF
- For CEPC, new opportunities on Charged Lepton Flavor Violation



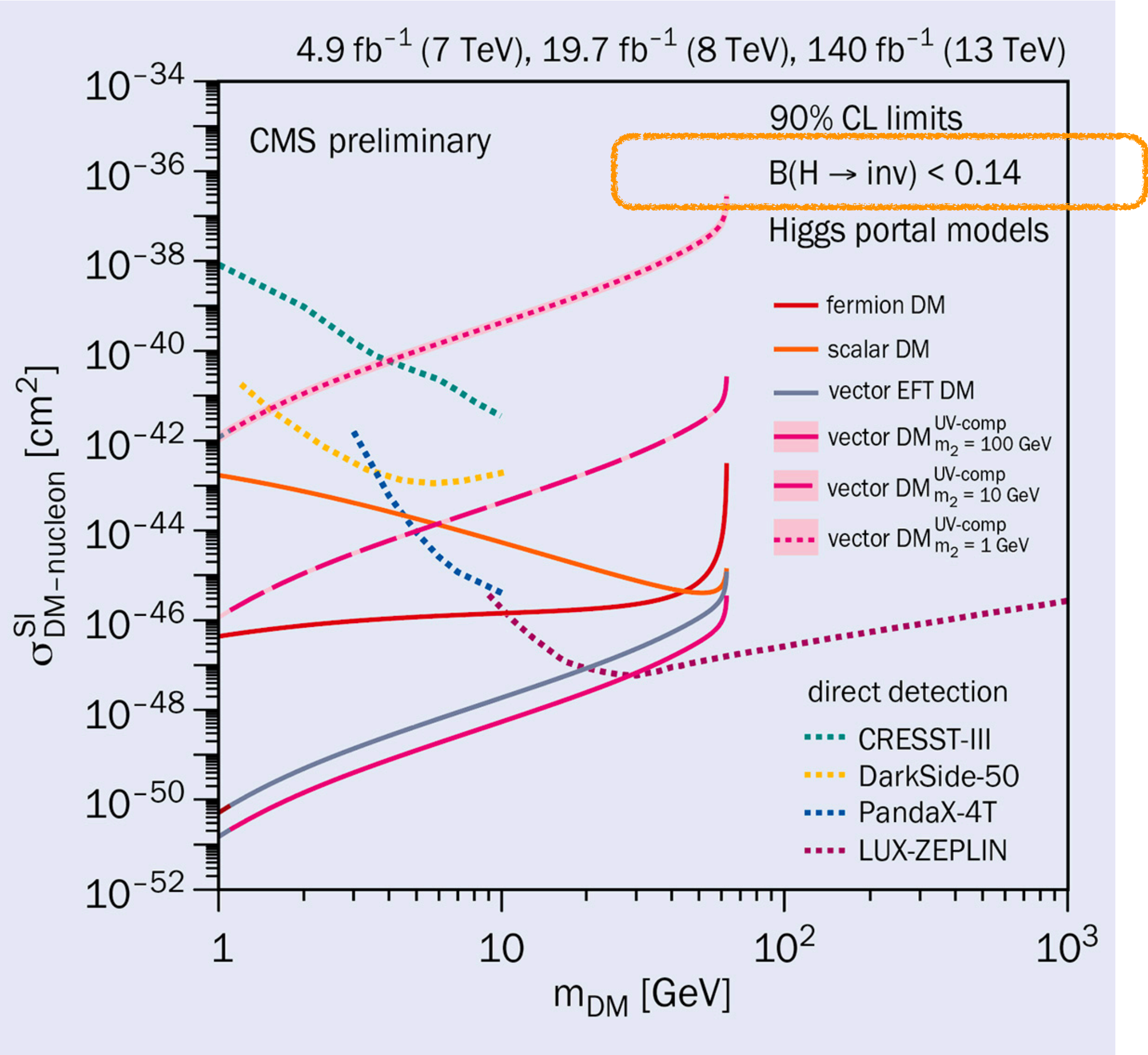
Outline

- Introduction
- BSM Higgs studies
 - Higgs [Exotic Decay](#)
 - Exotic [Light Higgs](#) Searches
 - Dark Sector scalars or pseudo-scalars [at Z-Factory](#)
 - Higgs [invisible decay](#) for Higgs Portal Dark Matter
- Summary

BSM Higgs studies IV: Invisible Higgs Decay

- Precision measurement for BSM Higgs
- Invisible Higgs test to **0.07%@CEPC**

	240 GeV, 20 ab ⁻¹		360 GeV, 1 ab ⁻¹		
	ZH	vvH	ZH	vvH	eeH
inclusive	0.26%		1.40%	\	\
H→bb	0.14%	1.59%	0.90%	1.10%	4.30%
H→cc	2.02%		8.80%	16%	20%
H→gg	0.81%		3.40%	4.50%	12%
H→WW	0.53%		2.80%	4.40%	6.50%
H→ZZ	4.17%		20%	21%	
H→ττ	0.42%		2.10%	4.20%	7.50%
H→γγ	3.02%		11%	16%	
H→μμ	6.36%		41%	57%	
H→Zγ	8.50%		35%		
Br _{upper} (H→inv.)	0.07%				
Γ _H	1.65%		1.10%		



Summary

- Future ee collider (CEPC/FCC-ee etc) provides valuable opportunities to test Standard Model and Beyond the SM physics
- The [BSM white paper project](#) is moving forward as scheduled
- [BSM Higgs](#) searches benefits from the high precision and unique environment of CEPC
 - [Exotic Higgs decay](#) at CEPC can benefit from “recoil mass” technique
 - [Exotic Light Higgs](#) Searches should be carried out at CEPC
 - [Dark Sector scalars or pseudo-scalars](#) related with Z boson can be tested at Z-Factory
 - [Higgs invisible decay](#) is a crucial test for Higgs Portaled Dark Matter
- CEPC offers a diverse and extensive research program covering various aspects for BSM Higgs

Thank you!

Backup slides

