

Update on the CP properties of H-V coupling in WW channel

University of Science and Technology of China

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Status

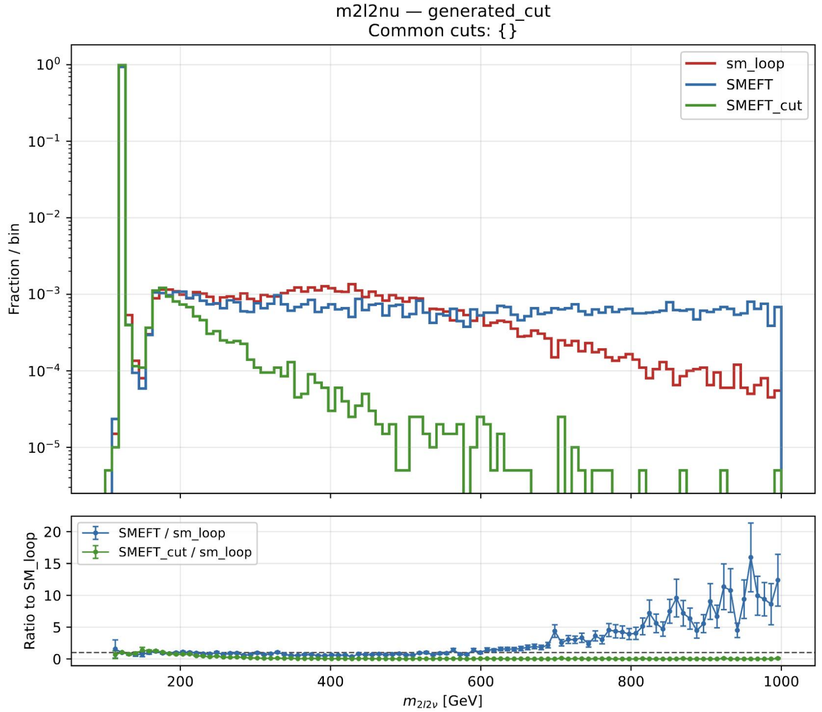
- Investigate the validate offshell region of ggF SMEFT sample, decided on the generation cuts 80 < m2l <200 GeV(generation) (CP Pheno meeting)

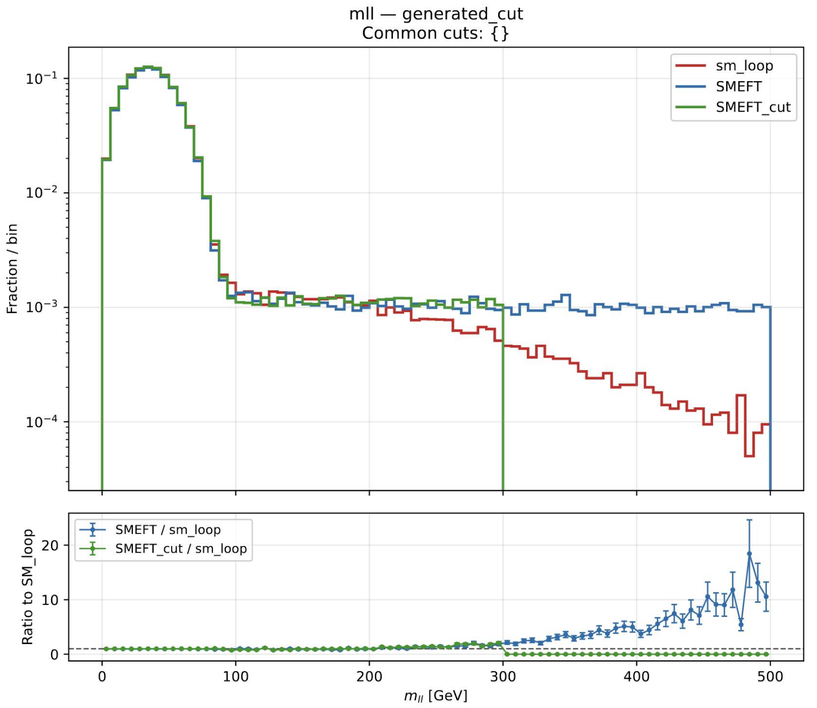
- The framework of the analysis has been set
  - Using GNN score to perform event categorization, choose $\Delta\varphi_{jj}$ as observable and parameterize the EFT operators and constrain them(CP Pheno meeting)
  - Combine EDM fit to constrain the CP odd operators

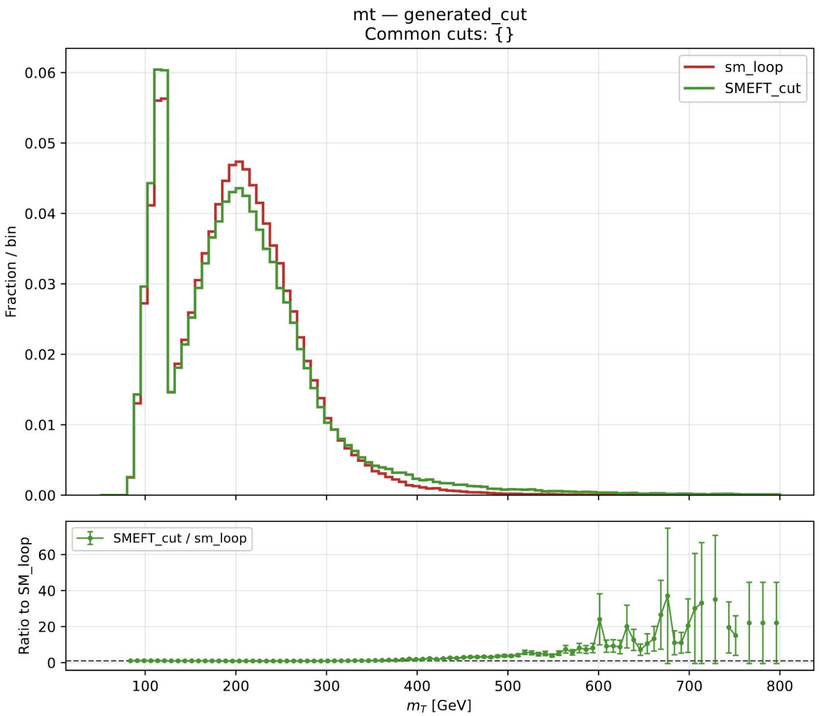
- Reanalysis with the updated ggF sample. Expected to complete all analyses by the end of this year

ggF Sample

- For offshell ggF SMEFT sample, it uses the assumption of infinite top mass, which is expected to break down around m_t
- So we add a generation cut on m_{2l} to avoid to include the unphysical tail
- Then add m_t cut (130 - 300 GeV) to selete the offshell events

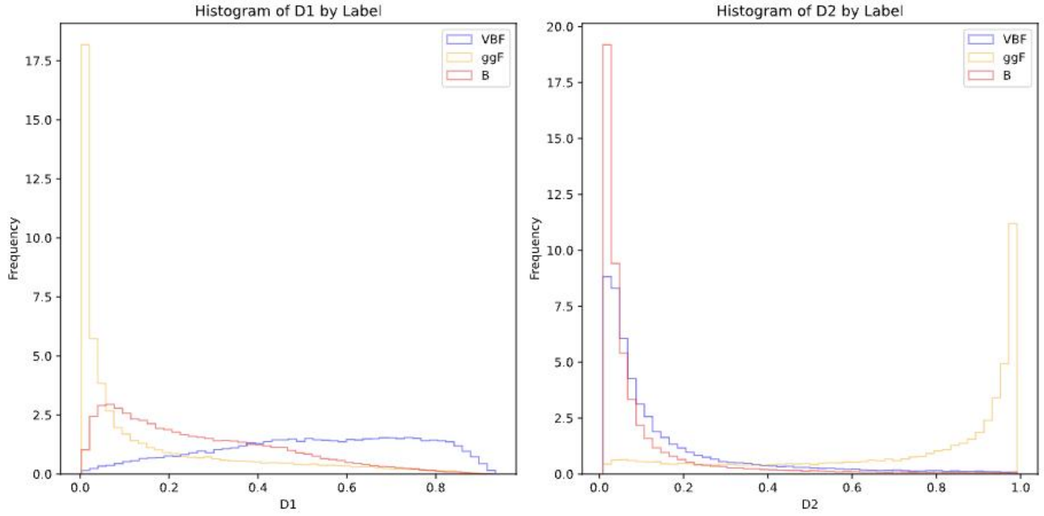


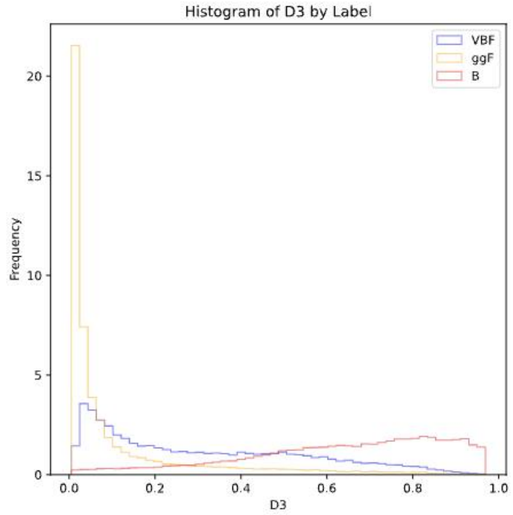


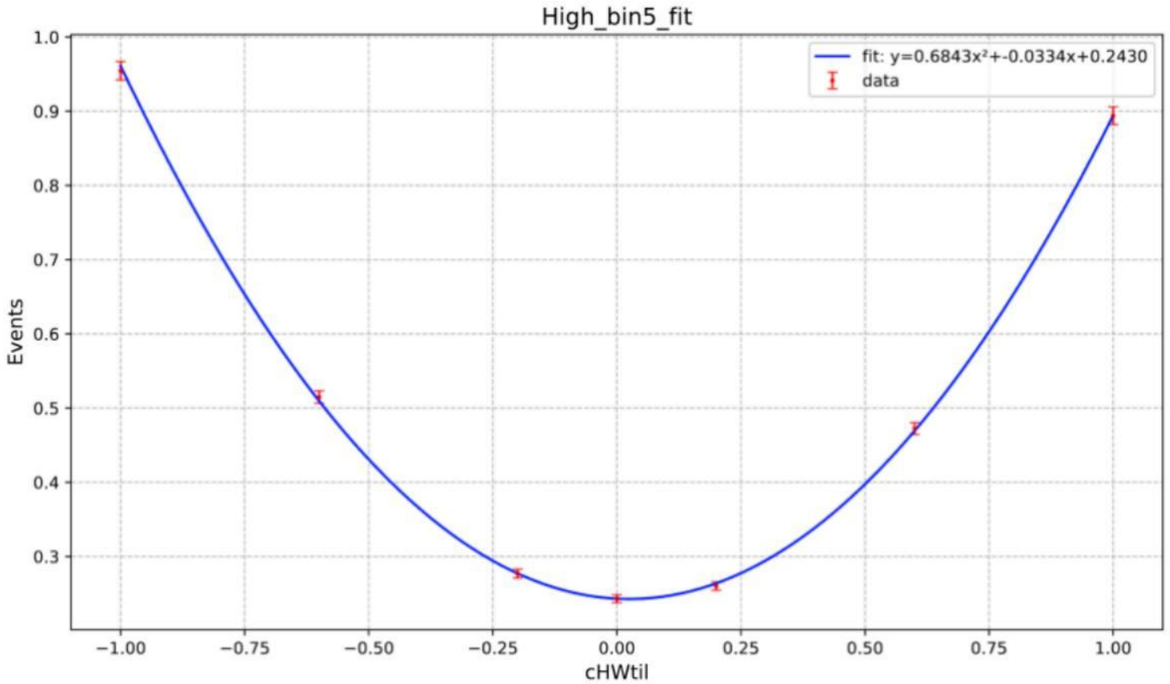


Event categorization and parameterize

- Using GNN score to perform event categorization, choose $\Delta\varphi_{jj}$ as observable and parameterize the EFT operators

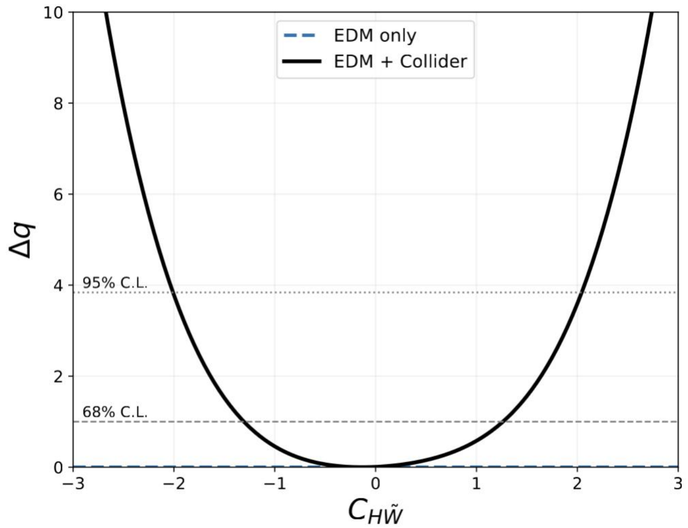


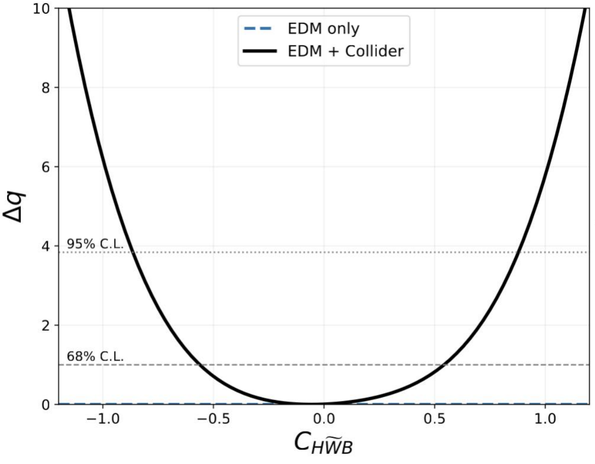


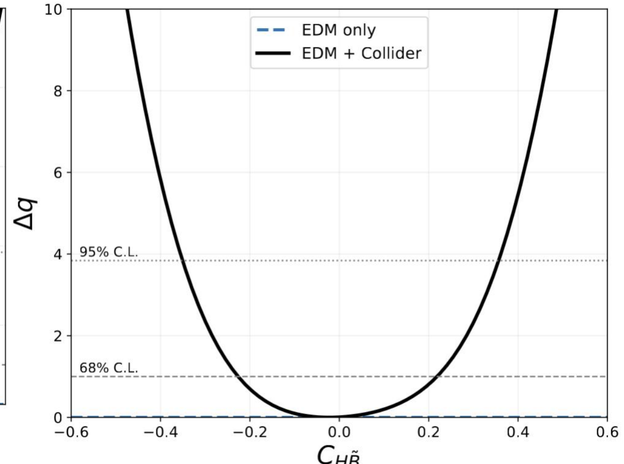


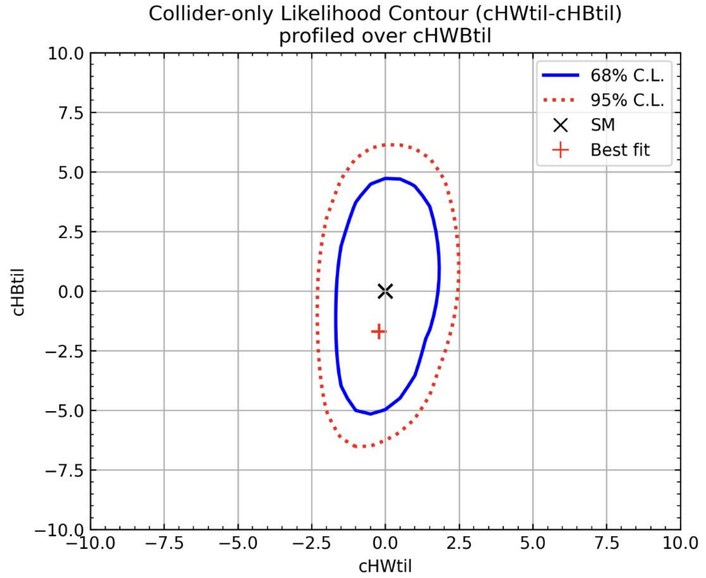
Collider constrains

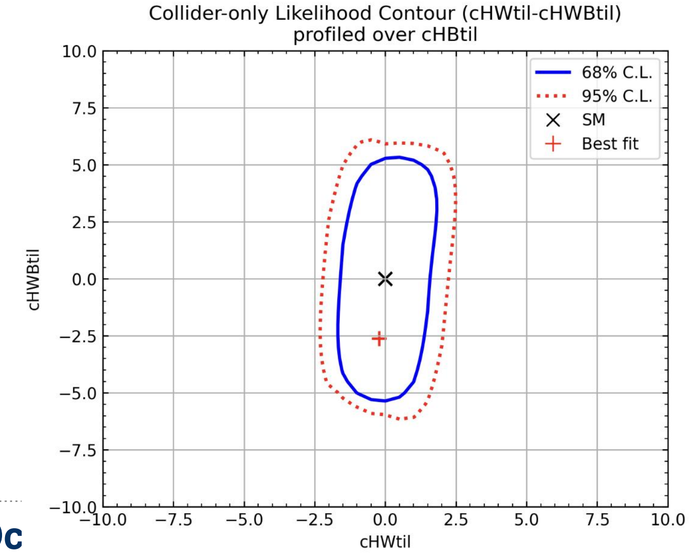
- Preliminary results with colloder constrains
- Need to be updated with new ggF sample

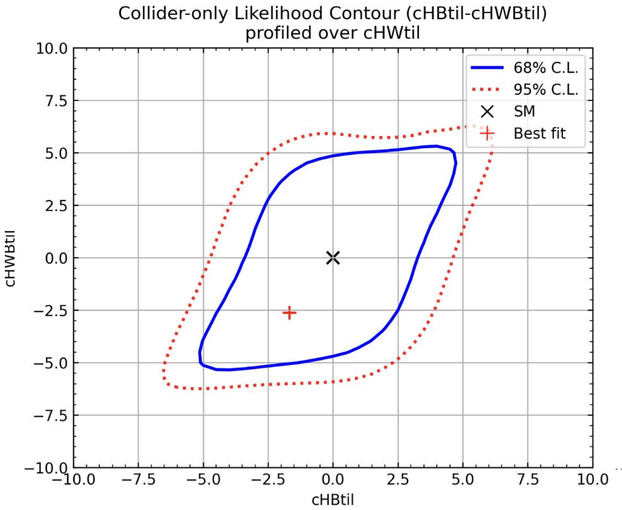






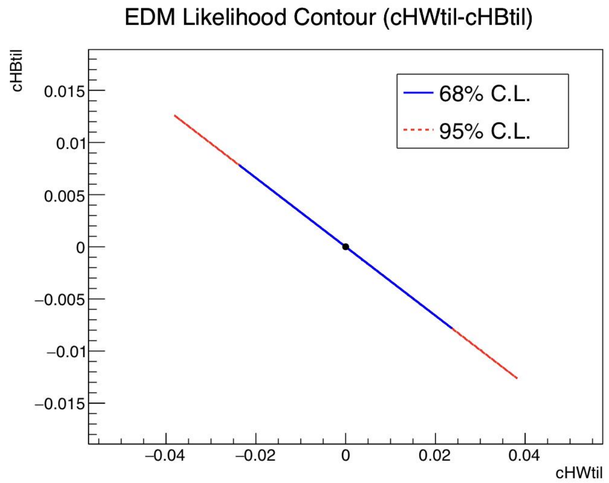


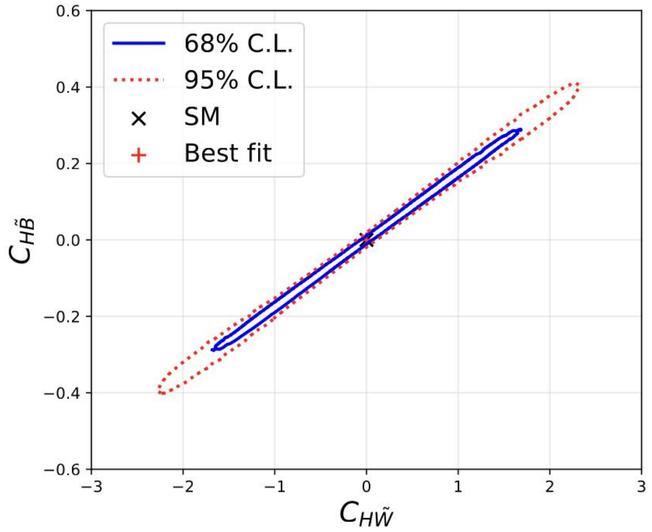


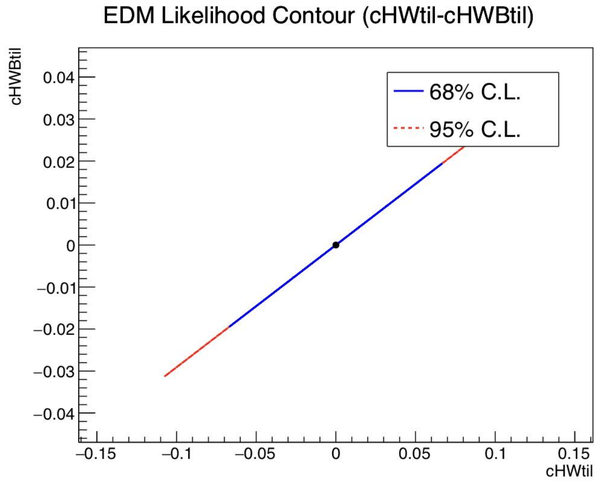


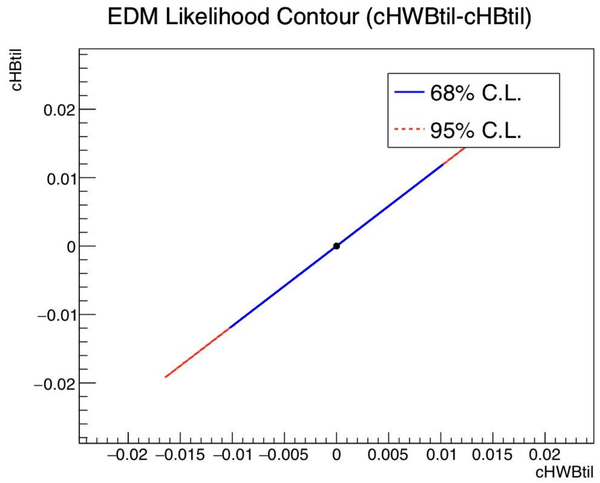
EDM constrains and combine with colider

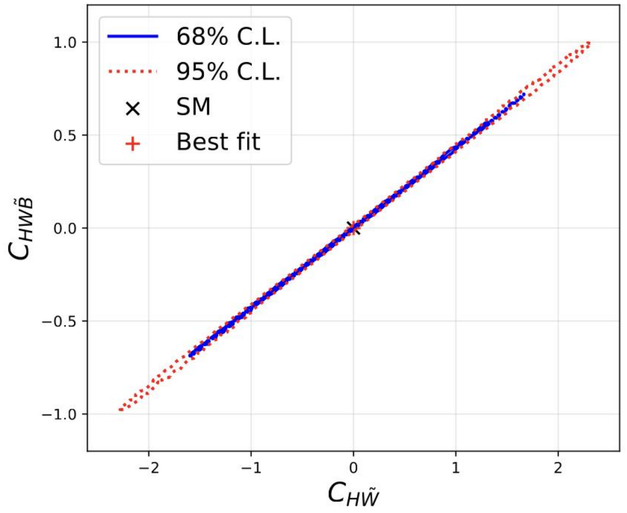
- Preliminary results from EDM constrains only and combination with collider information

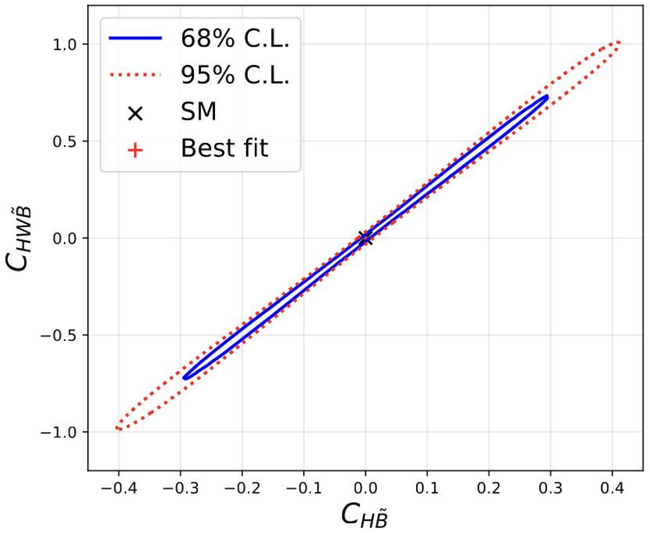












Summary

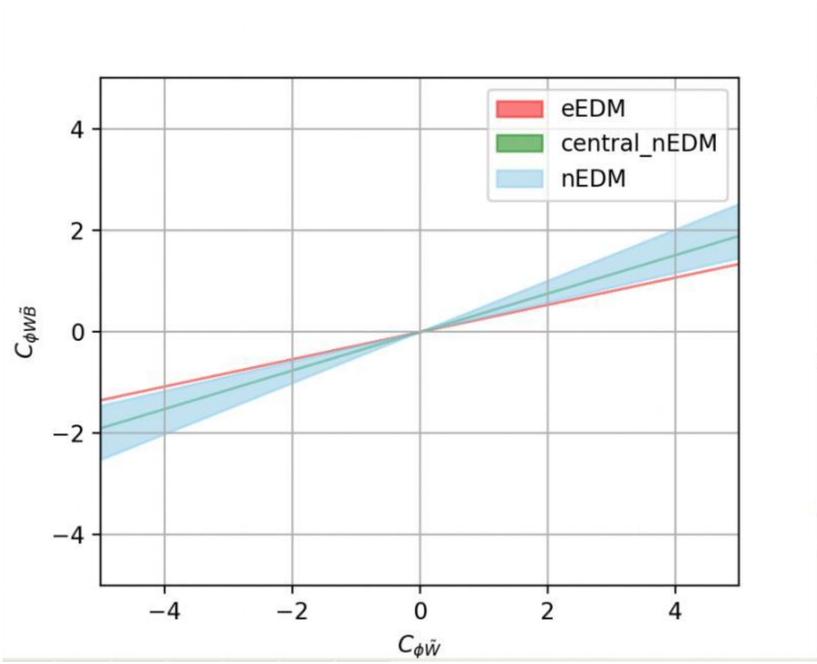
- Investigated the unexpected ggF sample behaviour and apply additional offshell cut to avoid unphysical tail

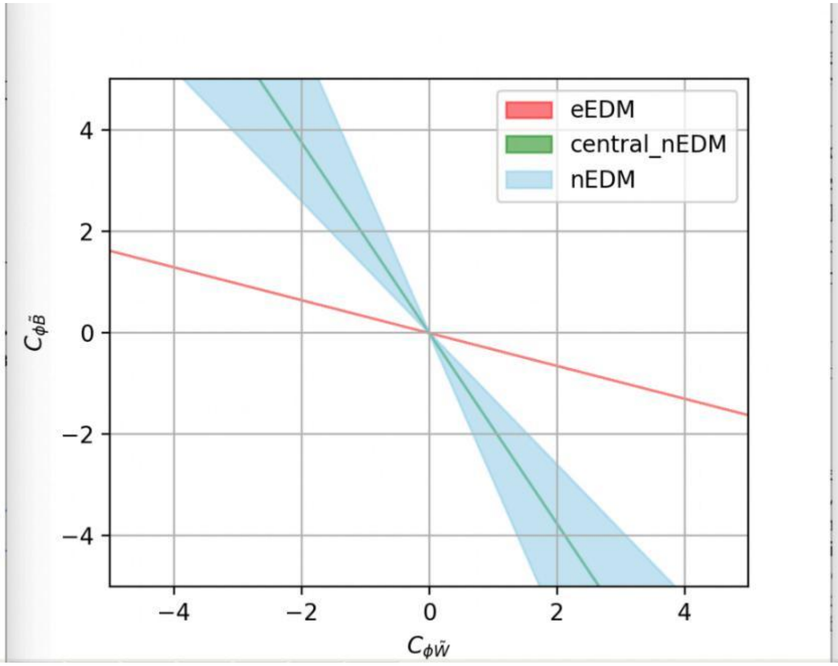
- The framework of the analysis has been set

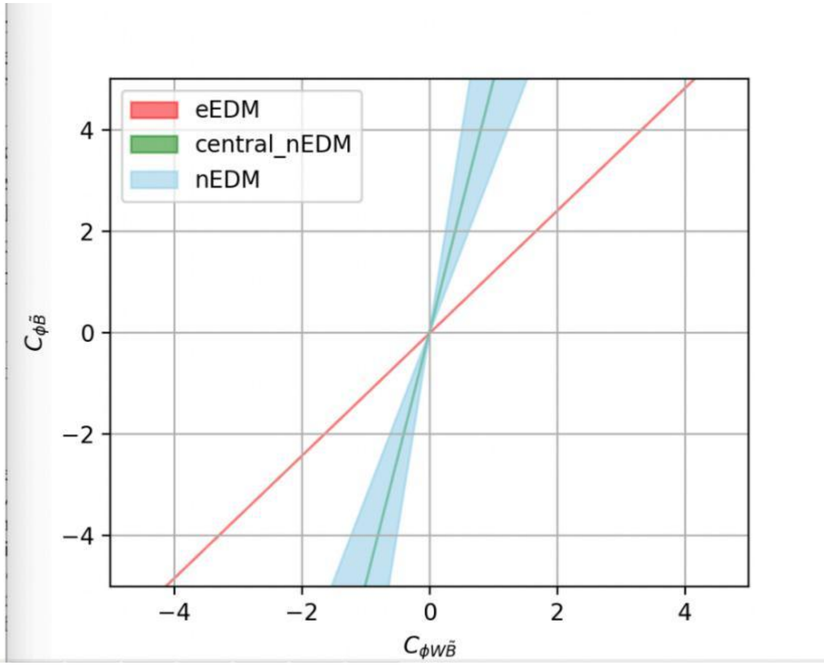
  Next step

  - Reanalysis with the updated ggF sample.
  - Optimize the performance of GNN training
  - Implement necessary uncertainties
  - Finalize the analysis steps

- Backup


eEDM
central_nEDM
nEDM
$C_{\phi W\tilde{B}}$
$C_{\phi\tilde{W}}$


eEDM
central_nEDM
nEDM
$C_{\phi\tilde{B}}$
$C_{\phi\tilde{W}}$


eEDM
central_nEDM
nEDM
$C_{\phi\tilde{B}}$
$C_{\phi W\tilde{B}}$

- EDM limits

electron EDM $|d_e| < 1.1 \times 10^{-29} e \cdot \text{cm}$

neutron EDM $|d_n| < 1.8 \times 10^{-26} e \cdot \text{cm}$ (90% CL)

Add a constraint likelihood beyond collider:

$$\vec{c} = \{c_{H\tilde{W}}, c_{H\tilde{B}}, c_{HW\tilde{B}}\}$$

$$\chi^2_{\text{total}}(\vec{c}) = \chi^2_{\text{LHC}}(\vec{c}) + \chi^2_{\text{EDM}}(\vec{c})$$

$$\chi^2_{\text{EDM}}(\vec{c}) = \sum_{i\in\{e,n\}} \frac{\left(d_i^{\text{th}} - d_i^{\text{exp}}\right)^2}{\sigma_i^2} + \chi^2_{\text{Lattice}}$$

Systematics:

$$\chi^2_{\text{Lattice}} = \frac{(g_u - 0.204)^2}{0.011^2} + \frac{(g_d - 0.784)^2}{0.028^2} + \frac{(g_s - 0.0027)^2}{0.0016^2}$$

Master formula: $\Lambda = 1$ TeV

$$d_e^{\text{th}} = \left(108.835\, c_{H\tilde{B}} + 35.820\, c_{H\tilde{W}} - 127.127\, c_{HW\tilde{B}}\right) 10^{-26} e \cdot \text{cm}$$

$$d_n^{\text{th}} = \Big[\left(80.4279\, c_{H\tilde{B}} + 174.347\, c_{H\tilde{W}} - 522.478\, c_{HW\tilde{B}}\right) g_d + \left(-1638.35\, c_{H\tilde{B}} - 3551.51\, c_{H\tilde{W}} + 10643.1\, c_{HW\tilde{B}}\right) g_s + \left(154.161\, c_{H\tilde{B}} + 85.5158\, c_{H\tilde{W}} + 40.3792\, c_{HW\tilde{B}}\right) g_u\Big] 10^{-26} e \cdot \text{cm}$$

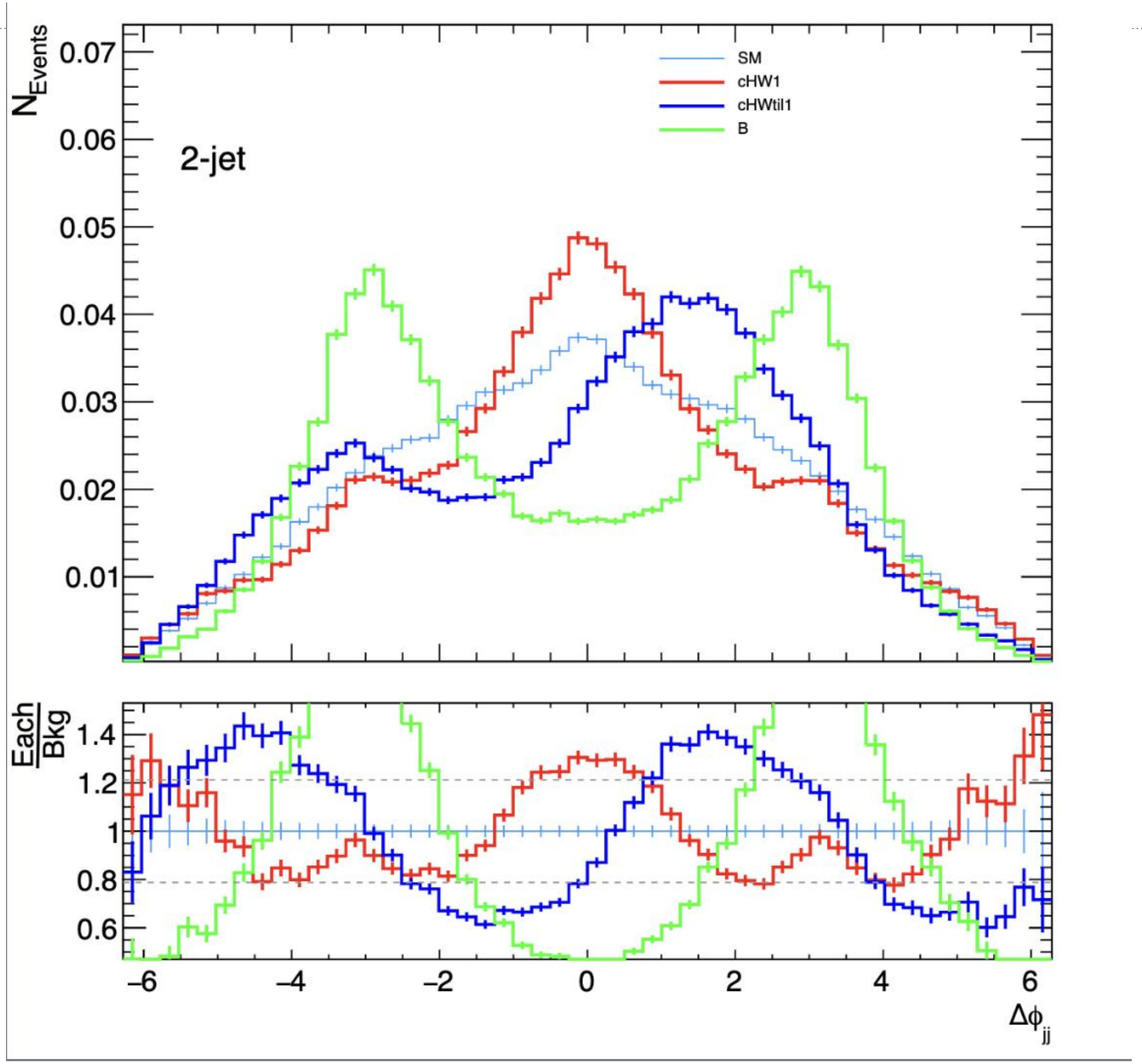
Task list

3）年度：2024 年 12 月—2025 年 5 月

- 任务：探索不同能量下双轻子末态及伴随产生喷注的动力学特征。指标：内部报告。
- 任务：构建对 CP 特性敏感的观测量。指标：内部报告。
- 任务：分析离壳产生对 H-V 耦合 CP 特性的测量范围。指标：内部报告。
- 任务：结合在壳产生的测量结果预测 Run-3 数据对 H-V 耦合 CP 特性的初步约束范围。指标：内部报告。

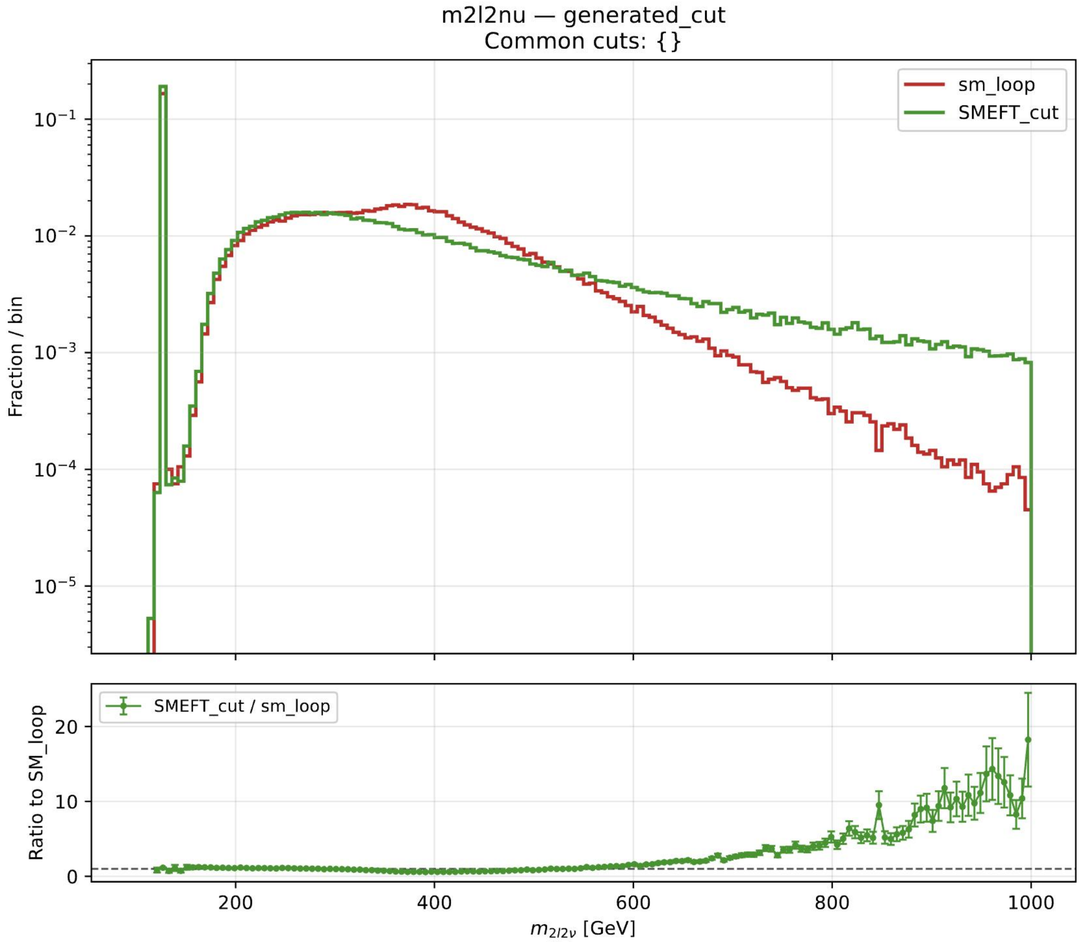
4）年度：2025 年 6 月—2025 年 11 月

- 任务：完成 H→WW 道测量$c_{H\widetilde{W}}$的约束范围的分析。指标：内部报告。
- 任务：总结 H→WW 道的分析结果并完成论文写作。指标：期刊文章。

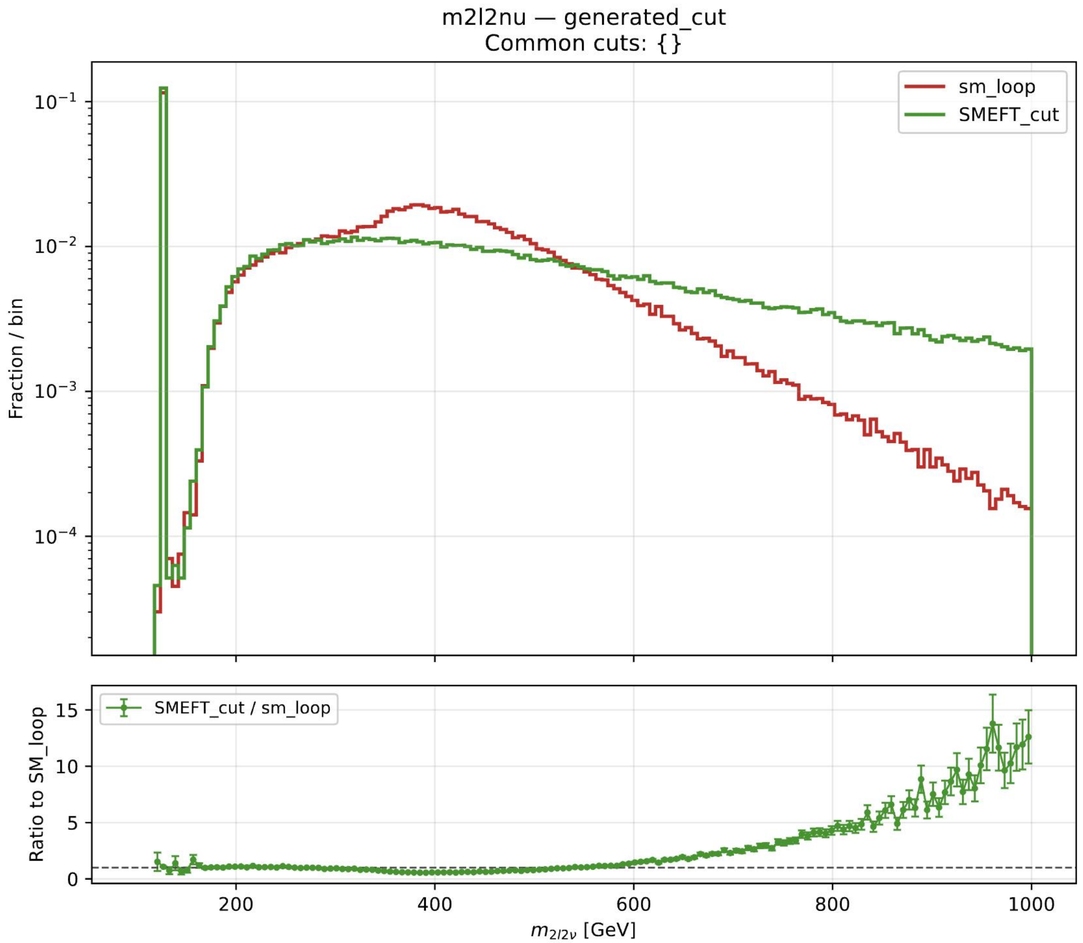

N_Events
0.07
0.06
0.05
0.04
0.03
0.02
0.01
SM
cHW1
cHWtil1
B
2-jet
Each/Bkg
1.4
1.2
1
0.8
0.6
−6
−4
−2
0
2
4
6
Δφ_jj

ggF sample

- 这里对SMEFT和sm_loop都加上m2l selection，看它们之间有没有好的一致性（m4l,m2l,mt和电子pt）



m2l 80~200 GeV



m2l 80~300 GeV