VBF $H \rightarrow \gamma\gamma$ CP workspace

Fangyi Guo

中国科学院高能物理研究所
Institute of High Energy Physics Chinese Academy of Sciences

Overview

- **HVV CP study in $H \to \gamma\gamma$ channel**
  - SMEFT Warsaw basis, $c_{H\widetilde{W}}$ as parameter.
  - CP observable: optimal observable OO. Divided into 6 bins.
  - Event classification: 2 BDTs $BDT_{VBF/ggF}$, $BDT_{VBF/continuum}$.

    4 categories are defined: TT, TL, LT, LL. TT, TL and LL are used.
  - Fit $m_{\gamma\gamma}$ shape in 3×6 BDT×OO bins.
  - Likelihood: $\mathcal{L}(\mu_{vbf}, N_{bkg}, \boldsymbol{\xi_{bkg}}, \boldsymbol{\theta}|m_{\gamma\gamma}) = \prod_i^{N_{bins}} Pois(n_i|\nu_i(\mu_{vbf}, \boldsymbol{\theta})) \prod_{j=1}^{n_i} f_i(m_{\gamma\gamma}^j; \boldsymbol{\theta}) \prod_k G(\theta_k)$

$$f_i(m_{\gamma\gamma}) = \frac{1}{\nu_i}\Big[(\mu_{vbf} \times N_{vbf}^i(\boldsymbol{\theta}) + N_{ggF}^i(\boldsymbol{\theta}) + N_{spur}^i \times \theta_{spur}^i) \times f_{sig}(m_{\gamma\gamma}; \mu_{\mathrm{CB}}^i(\boldsymbol{\theta}), \sigma_{\mathrm{CB}}^i(\boldsymbol{\theta}), \xi_{CB}^i) + N_{bkg}^i \times f_{bkg}(m_{\gamma\gamma}; \boldsymbol{\xi_{bkg}^i})\Big]$$

$$\nu_i = \mu_{vbf} \times N_{vbf}^i(\boldsymbol{\theta}) + N_{ggF}^i(\boldsymbol{\theta}) + N_{spur}^i \times \theta_{spur}^i + N_{bkg}^i$$

$$N_{vbf}^i(\boldsymbol{\theta}) = N_{vbf}^{i,nom} \times \prod_k Resp_k(\theta_k) \quad , \quad N_{ggF}^i(\boldsymbol{\theta}) = N_{ggF}^{i,nom} \times \prod_k Resp_k(\theta_k)$$

$$\mu_{\mathrm{CB}}^i(\boldsymbol{\theta}) = \mu_{\mathrm{CB}}^{i,nom} \times \prod_k Resp_k(\theta_k) \quad , \quad \sigma_{\mathrm{CB}}^i(\boldsymbol{\theta}) = \sigma_{\mathrm{CB}}^{i,nom} \times \prod_k Resp_k(\theta_k)$$

Parameterized workspace

- **Signal morphing:**
  - cross section $\sigma_{VBF}(c_{H\tilde{W}}) = \Sigma_i A_i c_{H\tilde{W}}^i = A_0 + A_1 c_{H\tilde{W}}(\text{linear}) + A_2 c_{H\tilde{W}}^2$ (quad).
    - Need 3 samples (SM, $c_{H\tilde{W}} = \pm 1$) to determine A_i.

- **Statistical model:**
  - $\mathcal{L} = \mathcal{L}(c_{H\tilde{W}}, \mu_{VBF}, N_{bkg}, \xi_{bkg}, \theta_{bkg} | m_{\gamma\gamma})$
    - $N_{VBF} = N_{VBF}(c_{H\tilde{W}}) = A_0 + A_1 c_{H\tilde{W}} + A_2 c_{H\tilde{W}}^2$.
    - Others are kept as constant to SM.
      - Different from now: NPs varies with $c_{H\tilde{W}}$.
  - Fit the model in TL category: $c_{H\tilde{W}} = 0^{+0.729}_{-0.734}$ (stat. only)
    - Need to check the difference.
  - Preparing a report in HComb meeting on Wednesday.

	$c_{H\tilde{W}} \pm unc.$ (stat.)(68% interval)
TT	$0.00^{+0.743\,(0.734)}_{-0.748\,(0.728)}$
TL	$0.00^{+0.769\,(0.767)}_{-0.763\,(0.762)}$
LT	$0.00^{+1.118\,(1.110)}_{-1.096\,(1.086)}$
combined	$0.00^{+0.476\,(0.473)}_{-0.475\,(0.471)}$