(trilinear Higgs coupling) $\lambda_{hhh} \cdot m_h$

(Higgs mass) and $v$ (vacuum expectation value)

**HH production at the LHC** provides direct access to $\lambda_{hhh}$

- **GGF**
- **VBF**

$H \rightarrow \gamma\gamma$ good mass resolution → CMS ECAL

Easy to detect over continuum backgrounds

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**Contribution backgrounds**

- **Non-resonant backgrounds:** $\gamma\gamma + \text{jets}, \gamma + \text{jets}, \text{tt} + \text{X}$
- **Resonant backgrounds:** single $H \rightarrow \gamma\gamma$

Among the $H$ production modes (ttH) has the largest contributions

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**Signal and background modelling**

- **2D parametric model of** $m_{\gamma\gamma}$ and $m_{bb}$ has been used
- **Signal and resonant background modelling:**
  - $m_{\gamma\gamma}$: multi Gaussian fit
  - $m_{bb}$: Double Sided Crystal Ball (DSCB) function
- **Non-resonant background** is directly modelled from Data
  - Discrete profile method
  - **F-Test** determines the polynomial function and its order

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**Final signal extraction** performed by simultaneous fit to all categories

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**Analysis Strategy**

- **Mutually exclusive event selections** for VBF HH and GGF HH
- **Multivariate analysis (MVA)** techniques used to separate background contamination
- **Further categorization based on** $M_X (M_{\gamma\gamma} - M_{\gamma\gamma} - M_{bb} + 250 \text{ GeV})$
- **MVA** output score

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$M_X$ is sensitive to probe beyond the standard model (BSM) physics

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**Results**

- **Upper limit on inclusive HH cross section** (in terms of SM predicted value)
  - **Observed:** $7.7$
  - **Expected:** $5.2$

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**ttH process**

- **Y_8 \lambda_{hhh}**
  - mutually exclusive to HH categories

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**Inclusion of ttH makes positive $\lambda_{hhh}$ preferable rules out negative $\gamma_t$ at 95% CL**