3/4 transparencies of comparison
HH non resonant analyses

Phenomenologically rich set of decay channel

Complementary sensitivity to different regions of the phase space

CMS is testing the 12 shape benchmarks
Important to have k factor as function of $k_\lambda$

Properly scaled the main ttH background once we moved to UL $(k_\lambda, k_t)$ plane
HH resonant analyses

**ATLAS**
\[ \sqrt{s} = 13 \text{ TeV}, 36.1 \text{ fb}^{-1} \]
- Observed limit
- Expected limit
- Expected limit ±1σ
- Expected limit ±2σ

**CMS preliminary**

Spin 0

- Observed 95% CL limit
- Expected 95% CL limit
- ± 1σ
- ± 2σ

UL based on narrow resonances to be added finite width (interference) to be added more production mechanisms

95% CL limit on \( \sigma(pp \rightarrow X \rightarrow HH) \) (fb)

Limit on \( \sigma(pp \rightarrow X \rightarrow HH) \) (fb)
HH HL-LHC extrapolations

Decay channel combination is essential for an evidence of HH production

<table>
<thead>
<tr>
<th></th>
<th>CMS</th>
<th>ATLAS</th>
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</thead>
<tbody>
<tr>
<td>bbbbb</td>
<td>$0.39\sigma$</td>
<td>$\mu &lt; 5.2(1.5)^{(3)}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$-4.1&lt;\lambda/\lambda_{SM}&lt;8.7$ ($0.2&lt;\lambda/\lambda_{SM}&lt;7.0$)</td>
</tr>
<tr>
<td>bb$\tau\tau$</td>
<td>$0.39\sigma^{(1)}/\mu &lt;1.6^{(2)}$</td>
<td>$\mu &lt;4.3^{(4)}$</td>
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<tr>
<td></td>
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<td>$-4.0&lt;\lambda/\lambda_{SM}&lt;12$</td>
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<tr>
<td>bb$\gamma\gamma$</td>
<td>$1.43\sigma$</td>
<td>$1.5\sigma^{(3)}$</td>
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<tr>
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<td></td>
<td>$0.2&lt;\lambda/\lambda_{SM}&lt;6.9$ (stat only)</td>
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<tr>
<td>bbVV</td>
<td>$0.45\sigma$</td>
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<tr>
<td>ttHH(bbbbb)</td>
<td></td>
<td>$0.35\sigma$</td>
</tr>
</tbody>
</table>

(1) CMS PAS FTR-16-002 (extrapolation of early ~3/fb Run-II)
(2) CERN-LHCC-2017-023 (updated projections)
(3) ATLAS ITK-2018-001 (improved wrt ATL-PHYS-PUB-2016-024)
(4) ATL-PHYS-PUB-2015-046

Analyses improve faster than the integrated luminosity scaling → some projections are conservative wrt latest Run 2 analyses

Updating the projections with state-of-the-art analyses/upgrade detector → motivates the preparation of updated projection (YR)