Gammatautau back of the envelope

- ggF cross-section is 48.52 nb at 13 TeV, hopefully 300 fb^{-1} in Run 2+3
- Assume very optimistic triggers (don't exist currently, but probably possible with 2 lepton + gamma signature)
- τ^1_{had} $p_T > 30$ GeV, τ^1_{had} $p_T > 20$ GeV
- ℓ^1 $p_T > 15$ GeV, τ^1_{had} $p_T > 20$ GeV
- ℓ^1 $p_T > 13$ GeV, ℓ^1 $p_T > 7$ GeV
- Know efficiencies for these selections from MC, so can estimate the number of $h \to \tau\tau$ events

Gammatautau back of the envelope

- $N(h \to \tau_\ell \tau_\ell) = 48.52 \cdot 300 \cdot 1000 \cdot 0.35 \cdot 0.35 \cdot 0.43 \cdot 0.0627 = 48074.4$
- $N(h \to \tau_\ell \tau_{had}) = 48.52 \cdot 300 \cdot 1000 \cdot 0.35 \cdot 0.65 \cdot 2 \cdot 0.16 \cdot 0.0627 = 66441.7$
- $N(h \to \tau_{had} \tau_{had}) = 48.52 \cdot 300 \cdot 1000 \cdot 0.65 \cdot 0.65 \cdot 0.45 \cdot 0.0627 = 173519.7$
- Need to scale by reconstruction and ID efficiency, being optimistic 90% for l, 80% for τ
- $N(h \to \tau\tau) = 48k * 0.9^2 + 66k * 0.9 * 0.8 + 174k * 0.8^2 \approx 197830$
- $197830 * 0.06 = 11870$
- This is based on pure $h \to \tau\tau$, adding additional γ to the system decreases average p_T of taus.

Gammatautau back of the envelope

In Run 2 $440k$ events expected in total, so overall we get a reasonable efficiency.

> Assuming SM predictions, about 2920 $H \to \tau\tau$ events (330, 1410, and 1180 events in the $\tau_e\tau_\mu$, $\tau_{\text{lep}}\tau_{\text{had}}$, and $\tau_{\text{had}}\tau_{\text{had}}$ channels respectively) are expected to be reconstructed and satisfy the event selection from the $\approx 440 \cdot 10^3$ $H \to \tau\tau$ events that were produced with $|y_H| < 2.5$ during the LHC Run 2. In data, 204 442 events are selected.

- HL LHC, ≈ 10 times the integrated luminosity
- Slightly higher collision energy $\implies$ 10% ggF cross-section increase.
- Have the possibility to design triggers specifically for the measurement.
- $O(100k)$ events that we can expect to get.
- Measuring 100 events asymmetry on top of $50k$ peak can be challenging.
- TODO: $h \to \tau\tau\gamma$ MC simulation to understand kinematics better.
- Maybe selection efficiency can be improved...