



Towards unified simplified fiducial selection for STXS in decay

Update from CMS

Antra Gaile, Giacomo Ortona, Matteo Bonanomi, Toni Sculac, Karlis Dreimanis

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STXS for Higgs boson decays

- Make **Higgs decay measurements** that can be used as input to theory interpretations
- The classification should be made based on the number and type of final state particles from the Higgs decay and their kinematic properties
- First step, define the fiducial selection!
- The simplified fiducial selection should:
 - be slightly “larger” than the experimental reconstruction selection;
 - have the same fiducial acceptance for SM and BSM models;
 - have only Lorentz invariant selection
- $H \rightarrow ZZ^* \rightarrow 4l$ case

Looking for a model independent ratio

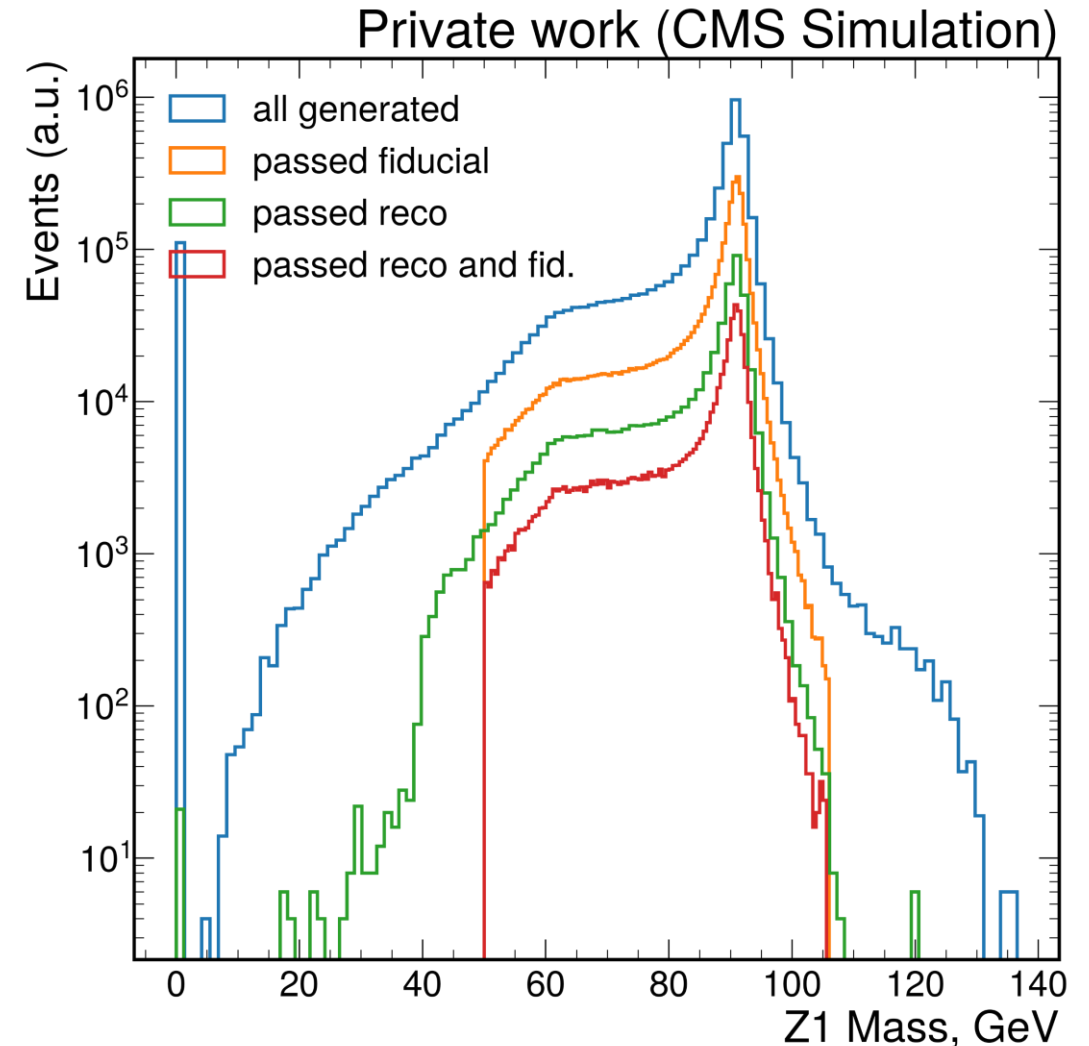
- Modifying fiducial selection to get same ratio distribution for SM and BSM, ideally flat

- Exploring if (reco&fid)/fid ratio is BSM model independent:

$$\text{ratio}_f = \frac{\text{pass reco\&pass fid. sel}}{\text{all that have passed fid. sel}}$$

- While keeping (reco&fid)/reco ratio as high as possible:

$$\text{ratio}_r = \frac{\text{pass reco\&pass fid. sel}}{\text{all that have passed reco sel}}$$



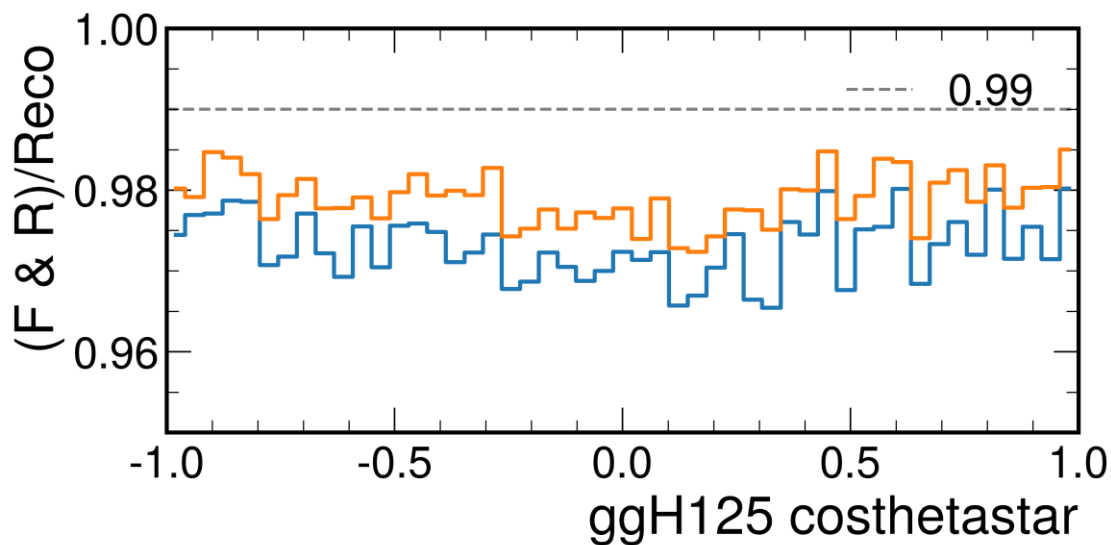
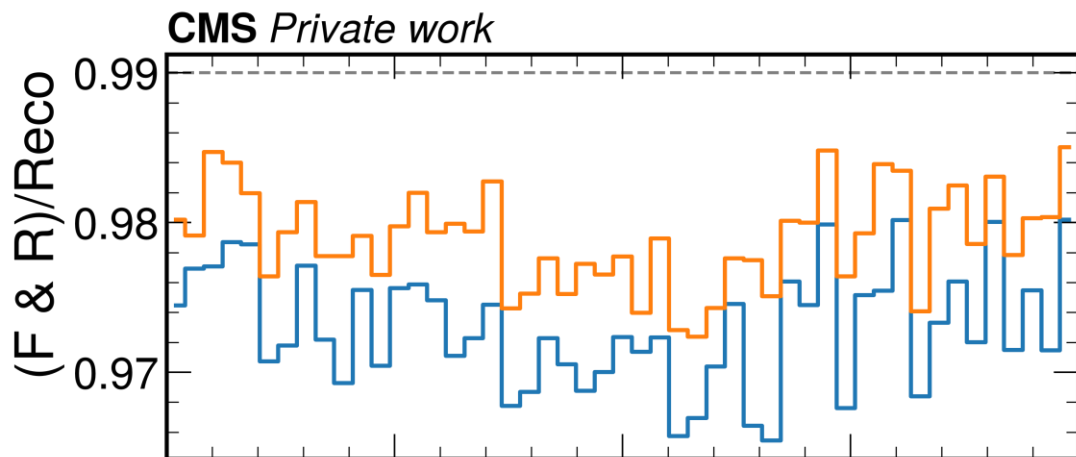
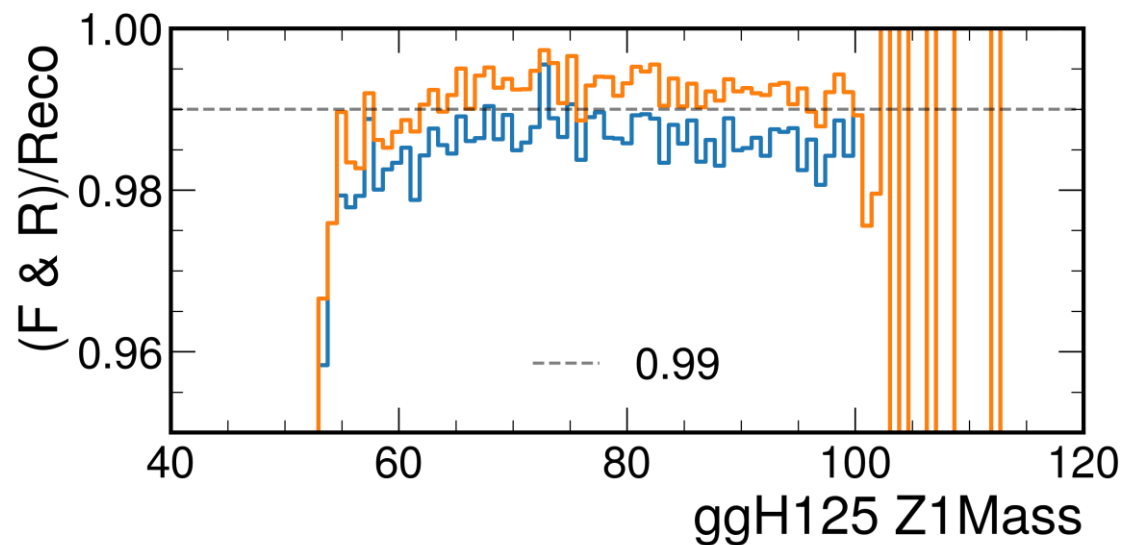
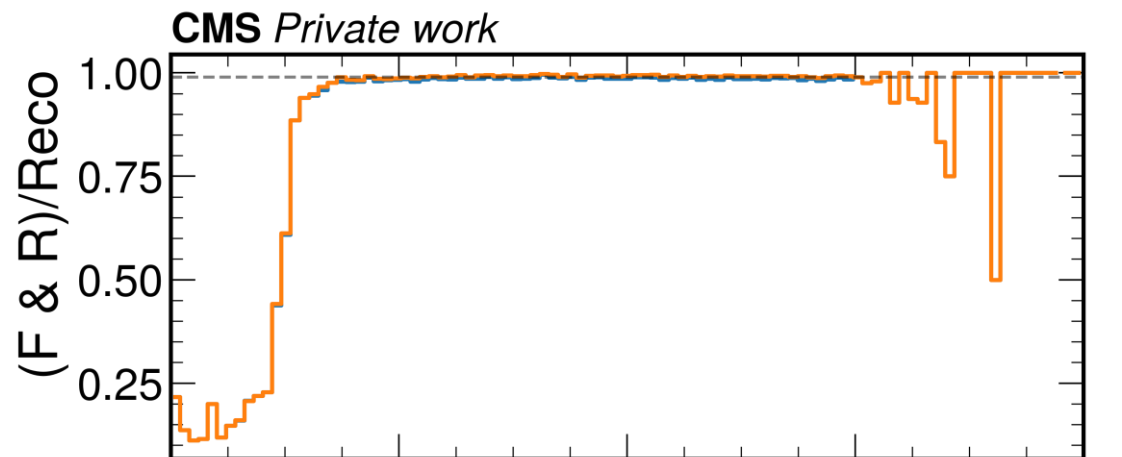
Changes in fiducial selection

Selection	CMS HIG-21-009	First simplified*	Today
Leading lepton	$p_T > 20 \text{ GeV}$	$p > 4 \text{ GeV}$	no restrictions
Sub-leading lepton	$p_T > 10 \text{ GeV}$	$p > 4 \text{ GeV}$	no restrictions
Additional electrons (muons)	$p_T > 7(5) \text{ GeV}$	$p > 4(4) \text{ GeV}$	no restrictions
Pseudorapidity of electrons (muons)	$ \eta < 2.5(2.4)$	no restrictions	no restrictions
Cone for dressing bare leptons with photons	$\Delta R = 0.3$	$\Delta R = 0.1$	$\Delta R = 0.1$
Inv. mass of the Z_1 candidate	$40 < m_{12} < 120 \text{ GeV}$	$50 < m_{12} < 106 \text{ GeV}$	$50 < m_{12} < 106 \text{ GeV}$
Inv. mass of the Z_2 candidate	$12 < m_{34} < 120 \text{ GeV}$	$12 < m_{34} < 115 \text{ GeV}$	$12 < m_{34} < 115 \text{ GeV}$
Distance between selected four leptons	$\Delta R_{ll} > 0.02$	$\Delta R_{ll} > 0.1$	$\Delta R_{ll} > 0.1$
Inv. mass of any opposite sign lepton pair	$m_{ll} > 4 \text{ GeV}$	$m_{ll} > 5 \text{ GeV}$	$m_{ll} > 4 \text{ GeV}$

* Almost identical to ATLAS simplified fiducial selection, exception: angle in ΔR place

- With ATLAS J/ψ window
- With CMS J/ψ window

$$\text{ratio}_r = \frac{\text{pass reco\&pass fid. sel}}{\text{all that have passed reco sel}}$$



Main take aways

- For ratio_f:
 - No significant change in ratio distribution
- For ratio_r:
 - No significant difference when no p cut is applied
 - removing the p>4 GeV cut was tried on the ATLAS side and seen not to cause issues too!
 - Biggest positive influence: J/ψ exclusion window
 - First proposal (matching ATLAS selection): $m_{ll} > 5$ GeV
 - Increased ratio_r (matching CMS selection): $m_{ll} > 4$ GeV
 - around 0.05 improvement, ratio_r for $Z_1 > 0.99$
 - Some value migration present when Z_1 mass window $Z_1 \in (50, 106)$ GeV as CMS reconstruction Z_1 mass window $Z_1 \in (40, 120)$ GeV

$$\text{ratio}_r = \frac{\text{pass reco\&pass fid. sel}}{\text{all that have passed reco sel}}$$

$$\text{ratio}_f = \frac{\text{pass reco\&pass fid. sel}}{\text{all that have passed fid. sel}}$$

How would J/ψ exclusion window $m_{ll} > 4$ GeV and looser Z_1 mass window **influence ATLAS's** results?

backup

$$\text{ratio}_f = \frac{\text{pass reco\&pass fid. sel}}{\text{all that have passed fid. sel}}$$

