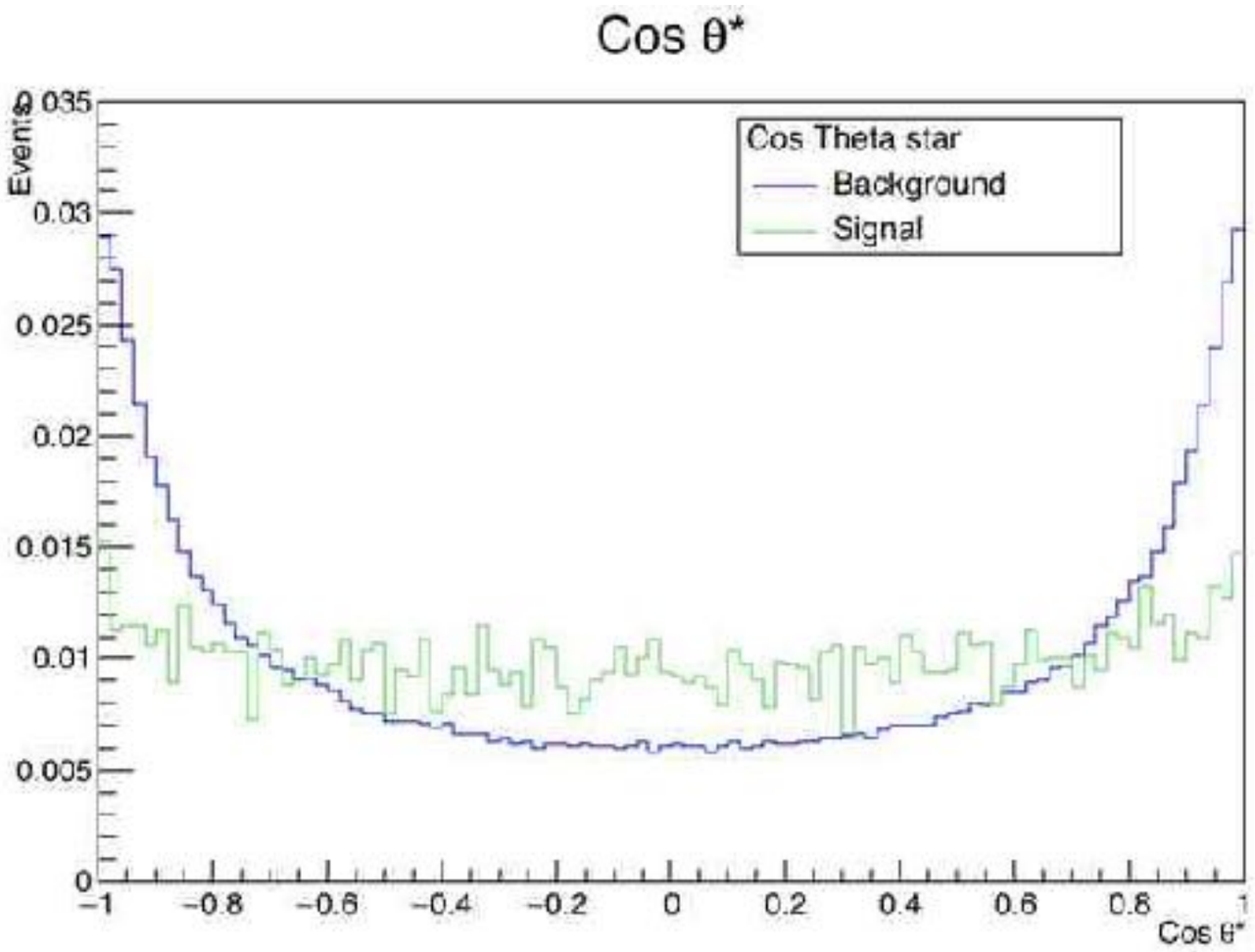
Angular Variables

Higgs to 4 Gamma

Tanvi Wamorkar

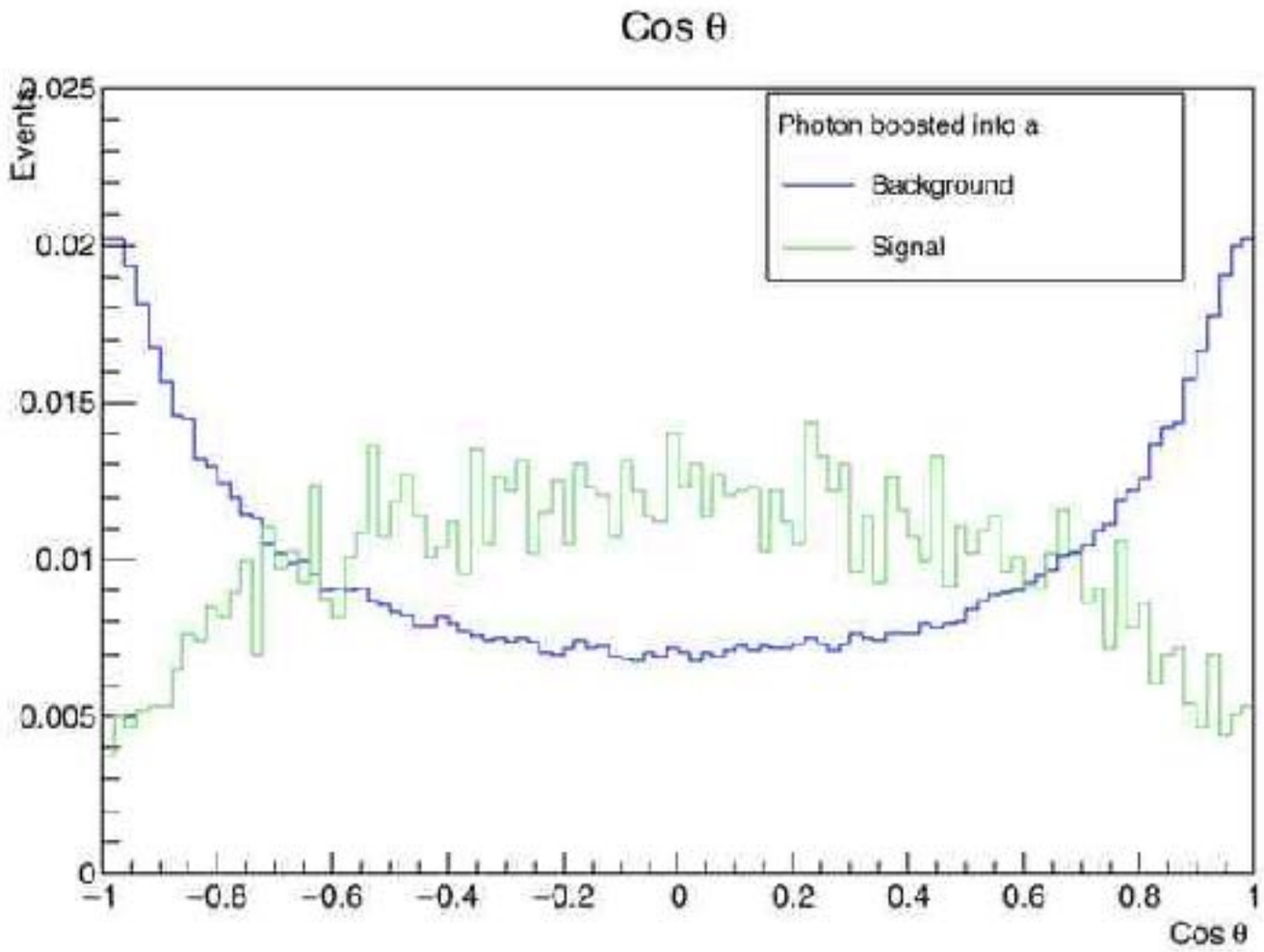
Cos Theta star



Signal and background look completely different

a1(a2) was boosted into the H rest frame and randomization was done to remove kinematic bias after which CosTheta of a1(or a2) was found

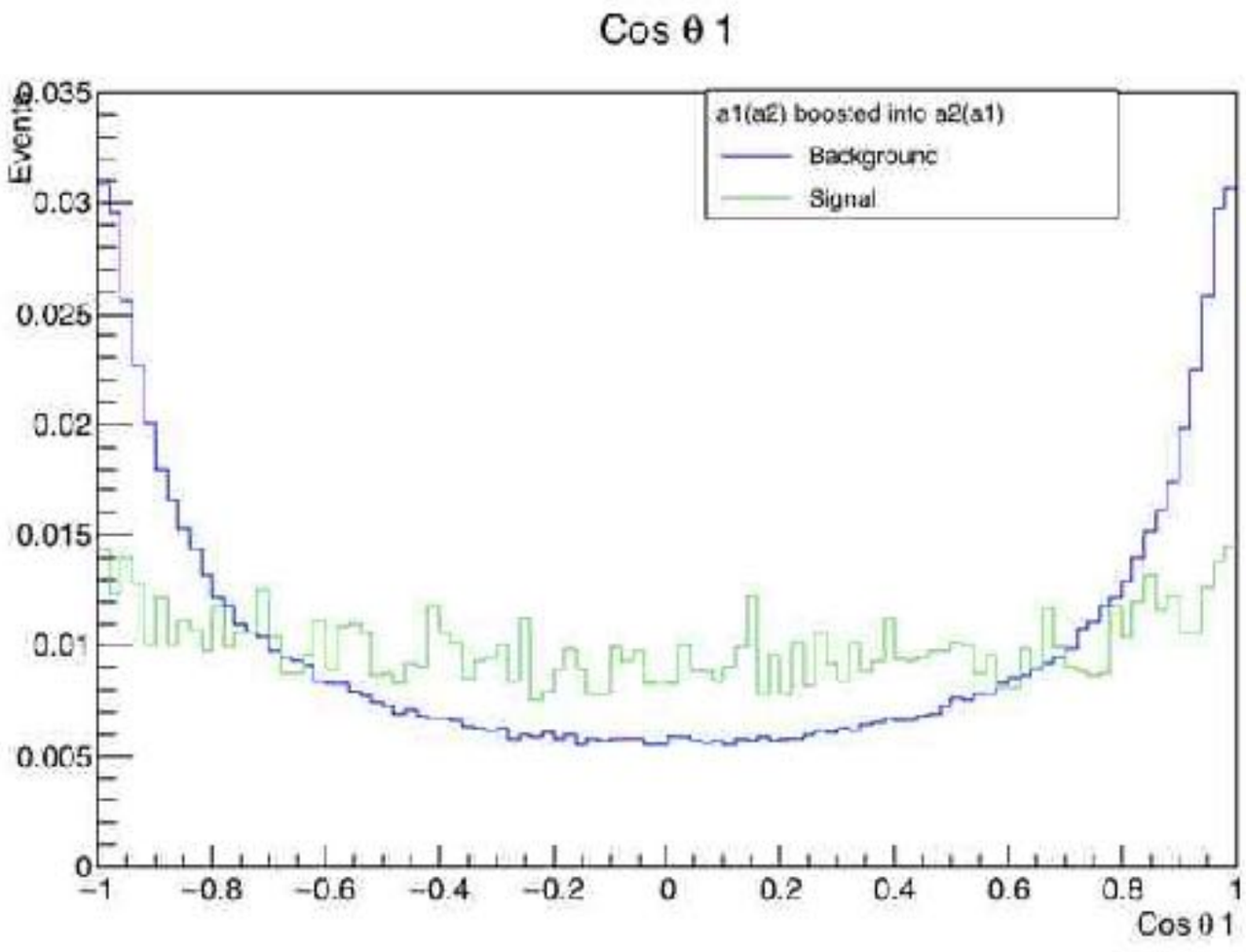
Cos Theta



Signal and background look different

Photons being produced by a1(a2) were boosted in the frame of a1(a2). The process of choosing a photon out of the two two released by a1(a2) was randomized. In addition to this the act of choosing between a1 and a2 was also randomized. Finally, the Cos theta of the randomized photon was found.

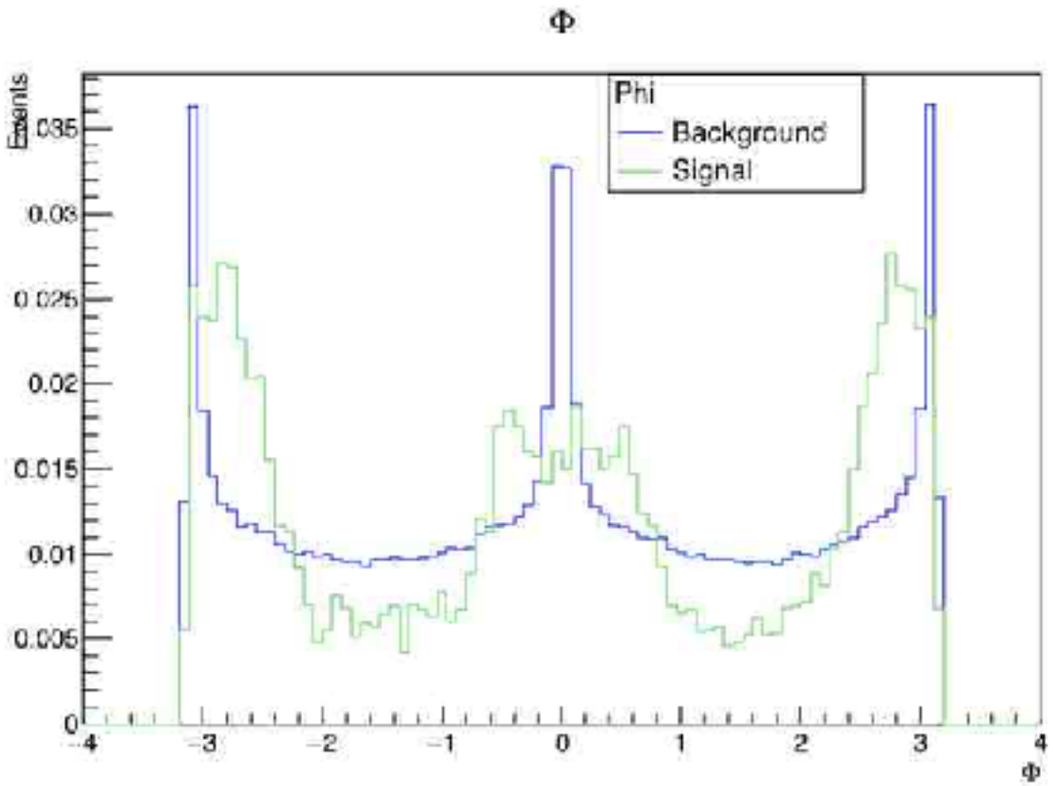
Cos Theta 1



This angle was found by boosting a1(a2) into the a2(a1) frame and finding the Cos Theta of a1(a2)

Signal and background look completely different

Phi



- Photons are first boosted into the Higgs rest frame
- Normal vectors are defined with cross products of the Photon momenta

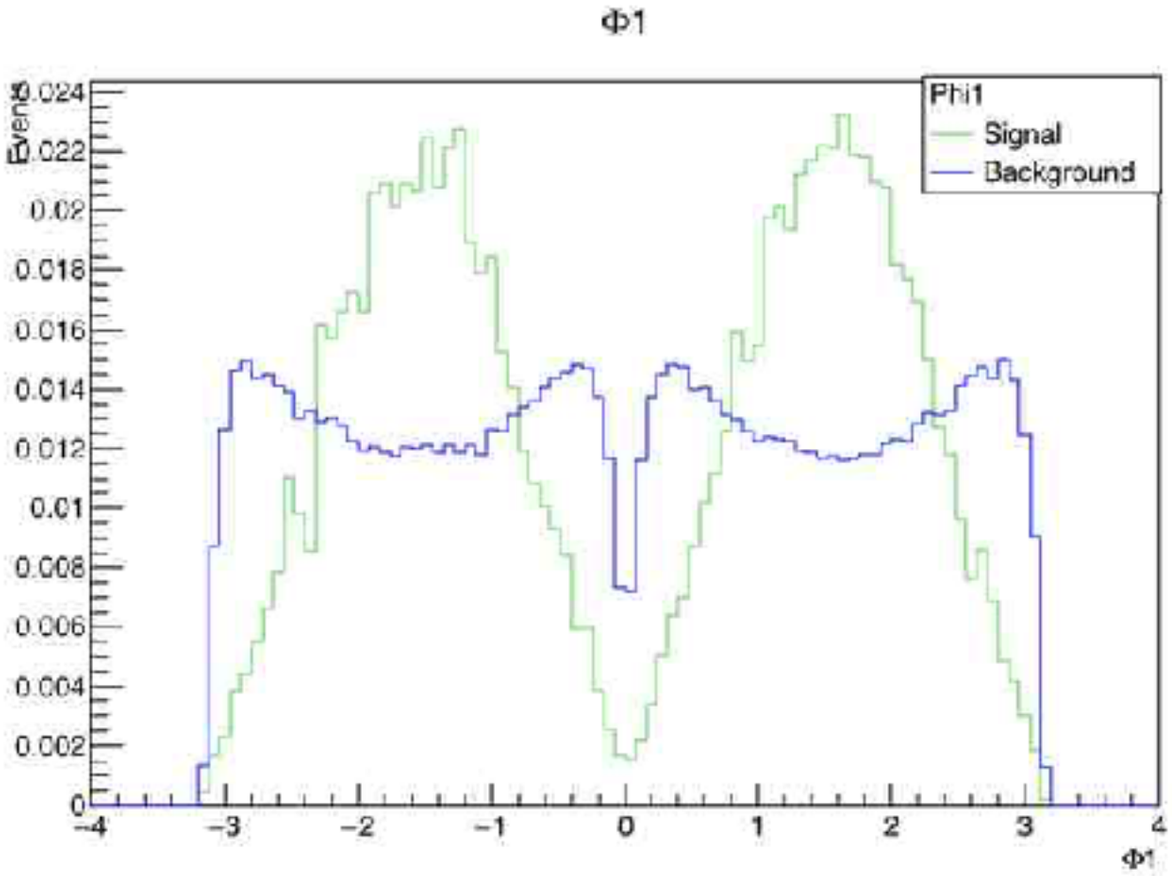
$$\hat{\boldsymbol{n}}_1 = \frac{\boldsymbol{q}_{11} \times \boldsymbol{q}_{12}}{|\boldsymbol{q}_{11} \times \boldsymbol{q}_{12}|}, \qquad \hat{\boldsymbol{n}}_2 = \frac{\boldsymbol{q}_{21} \times \boldsymbol{q}_{22}}{|\boldsymbol{q}_{21} \times \boldsymbol{q}_{22}|}, \quad \text{and} \quad \hat{\boldsymbol{n}}_{\text{sc}} = \frac{\hat{\boldsymbol{n}}_z \times \boldsymbol{q}_1}{|\hat{\boldsymbol{n}}_z \times \boldsymbol{q}_1|}.$$

Here q1 ~a1, q2~a2,q11~photon1,q12~photon2,q21~photon 3,q22~photon4 (all q's are 3 momenta)

Phi is defined as: $$\Phi = \frac{\boldsymbol{q}_1 \cdot (\hat{\boldsymbol{n}}_1 \times \hat{\boldsymbol{n}}_2)}{|\boldsymbol{q}_1 \cdot (\hat{\boldsymbol{n}}_1 \times \hat{\boldsymbol{n}}_2)|} \times \cos^{-1}(-\hat{\boldsymbol{n}}_1 \cdot \hat{\boldsymbol{n}}_2)$$

- Is Phi a good variable to distinguish between signal and background?
- Why does the background show peaks around -3 and 3?

Phi 1



$$\Phi_1 = \frac{\boldsymbol{q}_1 \cdot (\hat{\boldsymbol{n}}_1 \times \hat{\boldsymbol{n}}_{sc})}{|\boldsymbol{q}_1 \cdot (\hat{\boldsymbol{n}}_1 \times \hat{\boldsymbol{n}}_{sc})|} \times \cos^{-1}(\hat{\boldsymbol{n}}_1 \cdot \hat{\boldsymbol{n}}_{sc})$$

- Normal vectors have been defined in the previous slide
- Is this a good variable to differentiate between signal and background?