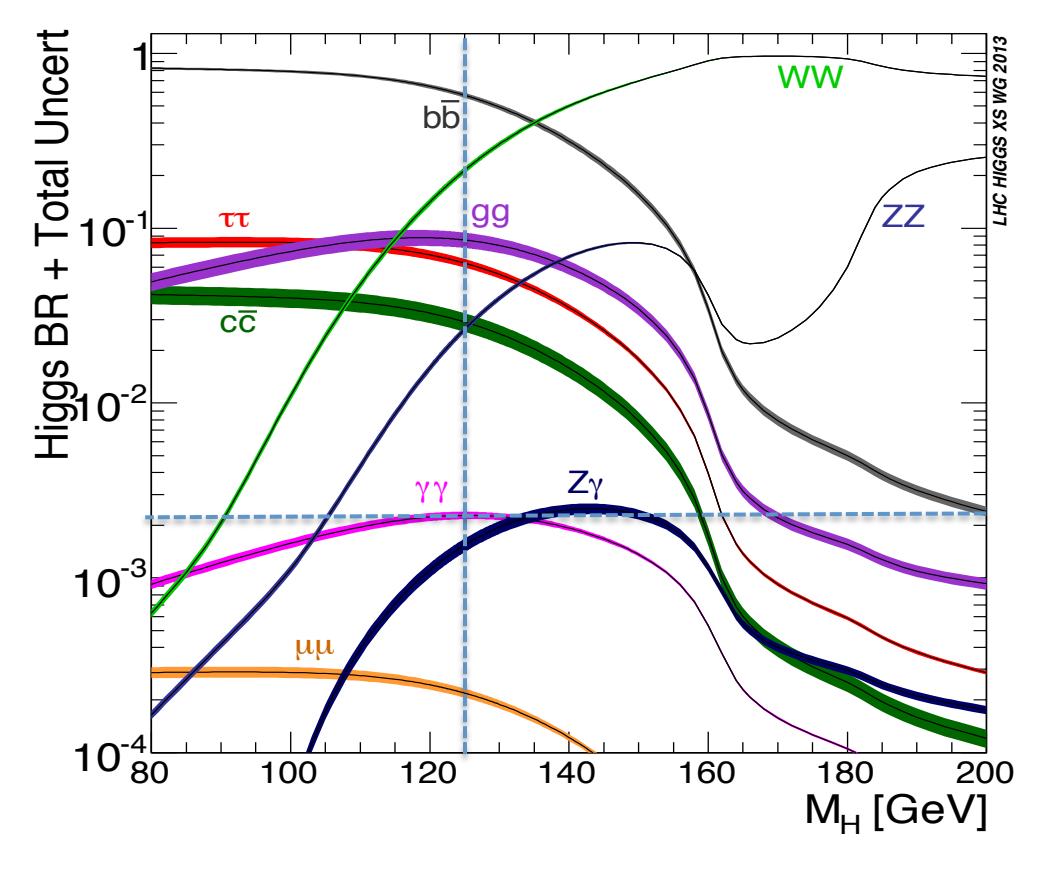


Introduction : In this poster results of two new measurements done in the Higgs to two photon decay channel with 8 TeV data are shown. These are the search for a low mass Higgs and the differential cross section. The low mass Higgs search is motivated by NMSSM, and the differential measurement can provide evidence of new physics.

The Higgs boson and the two photon decay

channel : Electroweak symmetry breaking is the accepted mechanism through which the vector bosons can acquire mass. The Higgs boson is the particle associated with this field for which we have looked for experimentally.

In particular, the two photon channel provides one of the cleanest signals despite its low branching ratio and high background.



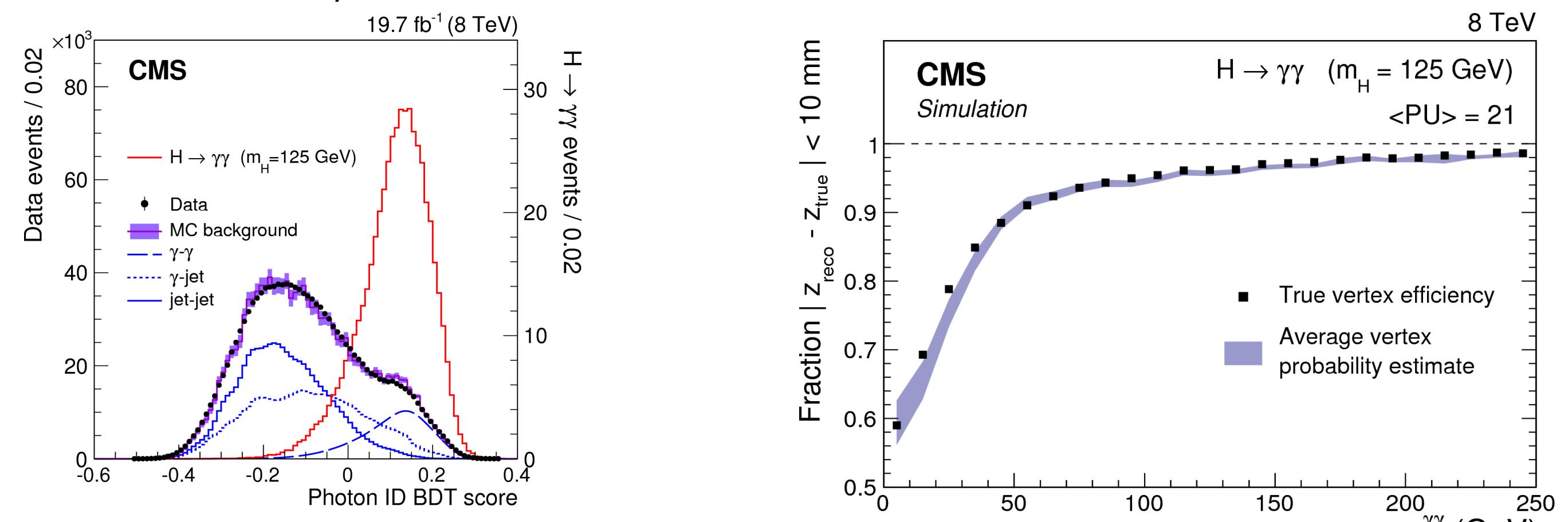
Here we can see that the two photon background is smoothly falling allowing for a relatively simple fit.

Key aspects of the Higgs to two photons analysis :

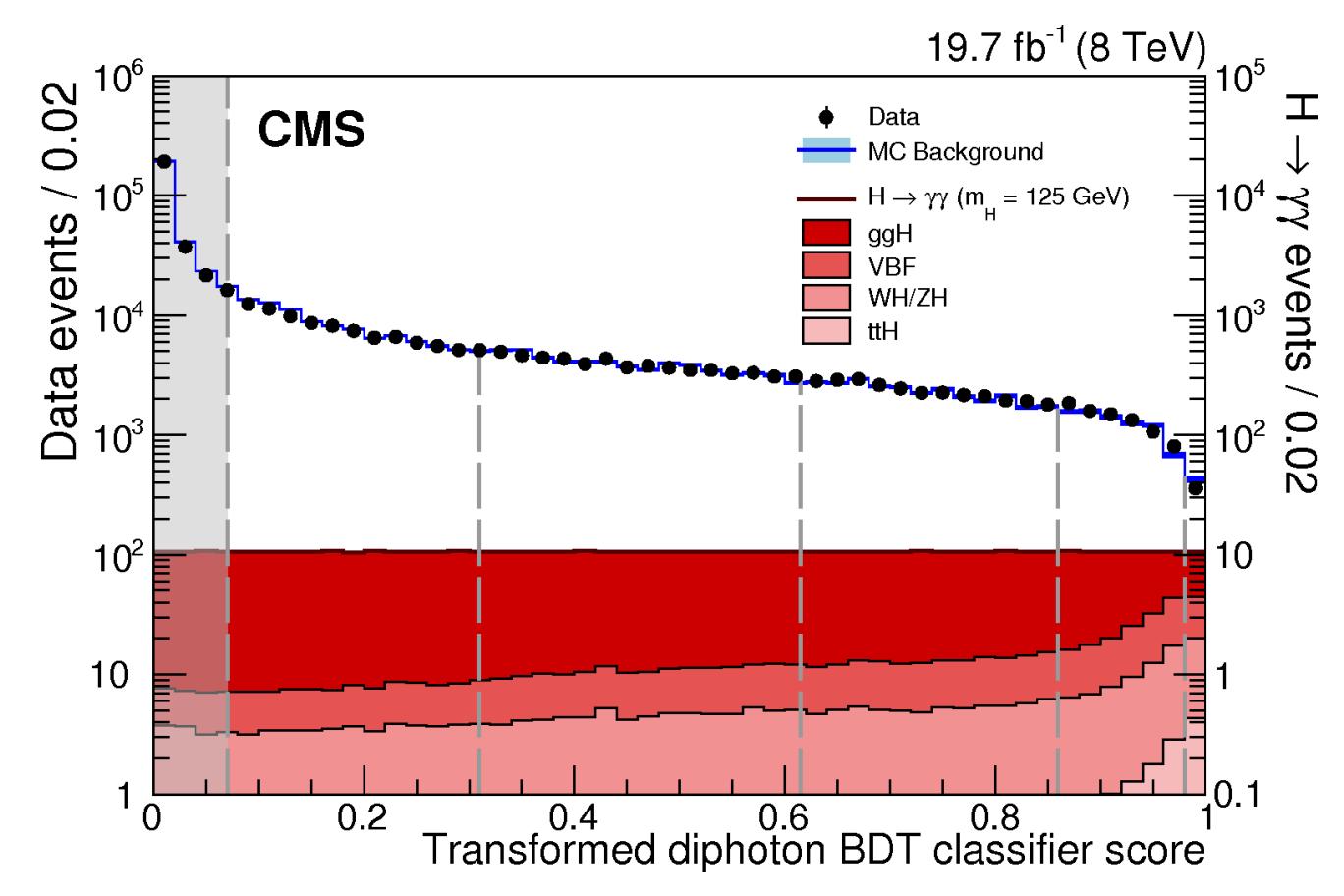
There are three major components for the event selection: the photon identification, vertex selection and diphoton identification.

The photon identification uses Boosted Decision Trees (BDTs) to score a photon as signal- or background-like based on its kinematics and shower shape.

The vertex identification BDT uses kinematic information from tracks as a function of vertex choice to score a vertex as correct or incorrect (this is later calibrated by another BDT using overall vertex information plus scores from the previous vertex BDT).

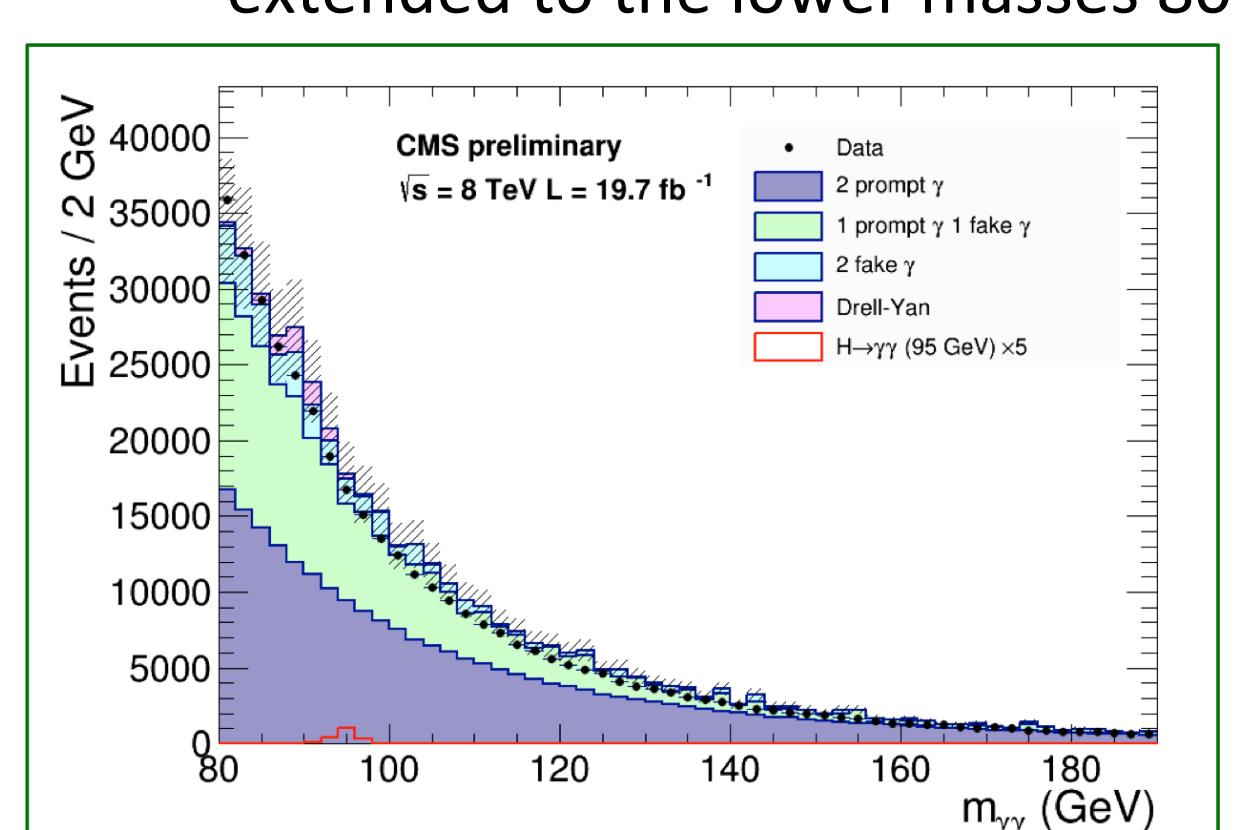


The diphoton identification uses information from the previous BDTs plus kinematic information from the diphoton system.



Here we can already see the classification of events to different regions of diphoton identification value depicted by the dashed lines.

Low mass Higgs search: The motivation for this search comes from extensive 2HDM phenomenological studies which in this case is motivated by NMSSM. Building upon the diphoton analysis, the search for an additional Higgs boson can be extended to the lower masses 80-110 GeV.

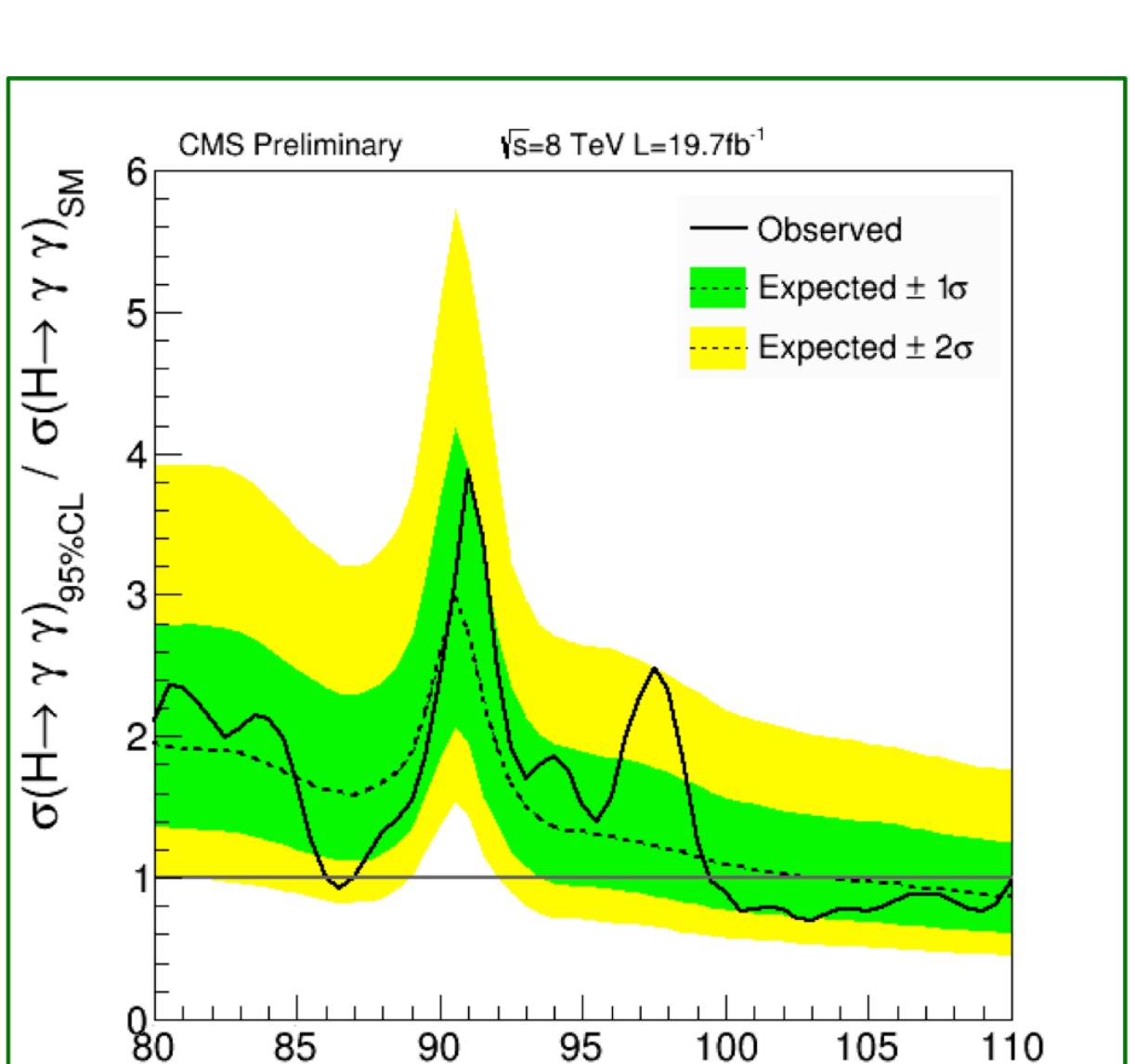


The biggest challenge to this search is the modeling of the background due to the remaining Z peak in the background spectrum.

Photons can be faked by electrons whenever their tracks don't directly point to a super cluster hit or simply manage to not leave a trace in the tracker. The first case can be handled by rejecting all photons who share the super cluster (within some radius) with a charged track that has at least two hits in the pixel detector.

Results:

No significant excess is observed. The significance of highest excess corresponds to 1.9σ at $m_H = 97.5$ GeV.



Differential Cross Section Measurement:

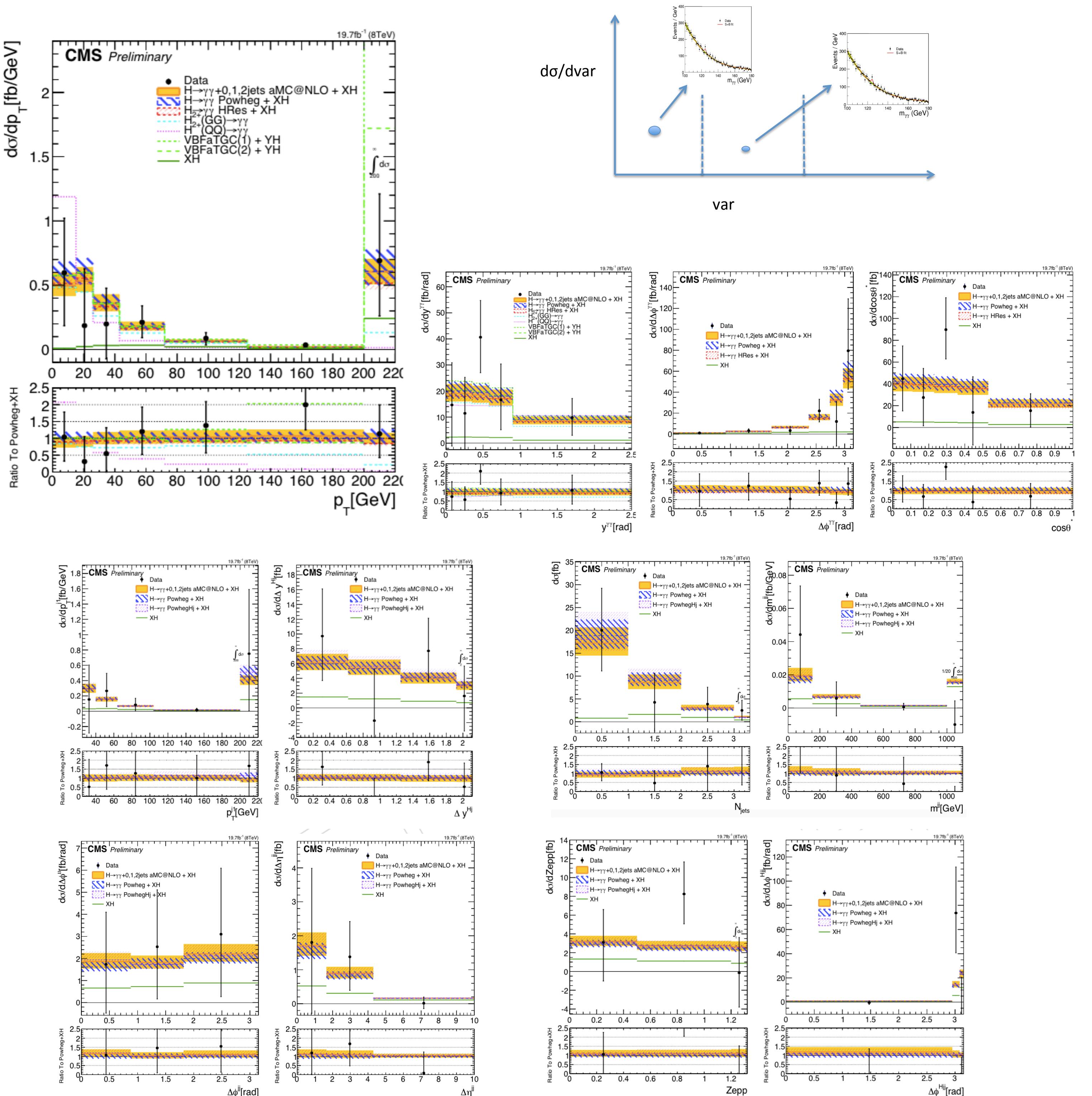
Higgs to two photons is an ideal channel for the cross section measurement. We have a fully reconstructed final state (two photons, or more objects depending on the event interpretation) and therefore can measure the differential cross section for many variables. There are two major innovations in the Higgs to two photon approach : The decorrelation of the mass resolution (σ_M/M) variable to energy resolution (σ_E/E) and the unfolding strategy.

- σ_M/M : Constrained by statistics, the event categorization is done by mass resolution regions. In order to keep a smooth background spectrum it is necessary to keep this variable decorrelated as a function of the energy resolution. There are two steps, first decorrelation against σ_E/E and η simultaneously then restoring back the η dependence to account for detector performance in different η regions.
- **Unfolding :** Unfolding is a method of removing the smearing effects of the detector on the original distribution of an observable. $y_j = \hat{A}_{ij}\lambda_i + b_j$ where λ is the original distribution.

Here unfolding is done by the following formula

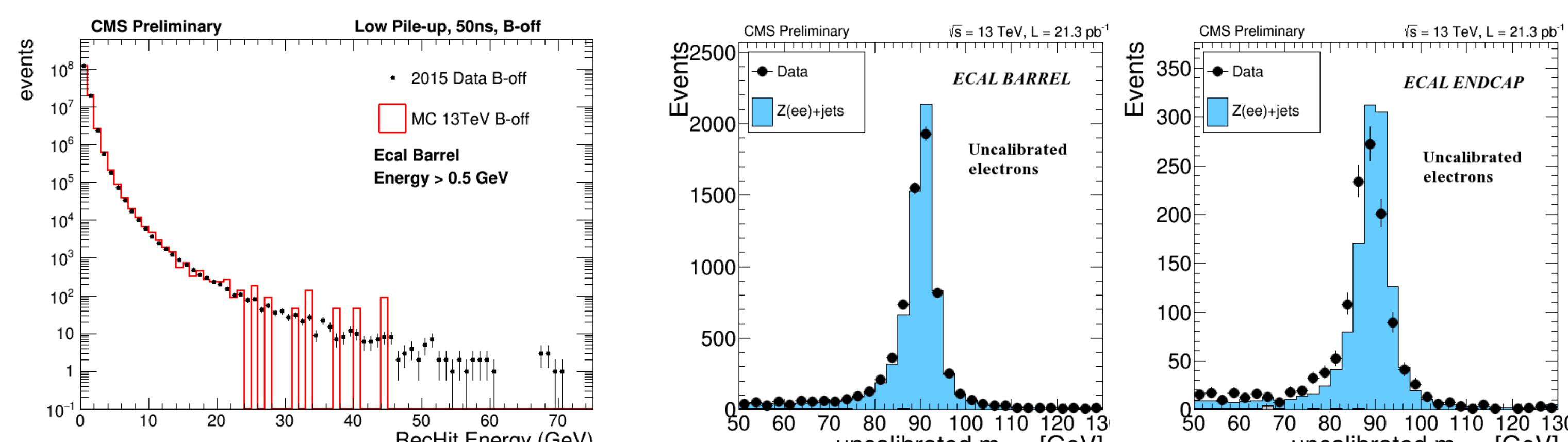
$$\mathcal{F}(\mu_i) = -2 \log \mathcal{L}(K_{ij} \cdot \mu_i \cdot N_{gen,i} | N_{reco,j})$$

where the variables are K_{ij} the response matrix, μ_i unknown signal strength modifier at particle level, $N_{gen,i}$ assumed particle level distribution of kinematic observables and $N_{reco,j}$ number of events in each bin of the measured distribution.



13 TeV data hot off the LHC!

With the start of Run II in June 1st it is very exciting to start looking at the data as soon as possible. Here we see some of the first approved plots from the CMS Electromagnetic Calorimeter (ECAL) with 13 TeV data. The two plots on the right are reconstructed Z->ee events with both electrons in the ECAL at 13 TeV and 50 ns bunch spacing. The plot on the left is a data/MC comparison of the rechit energy at 13 TeV, 50 ns bunch spacing and B=0T.



Currently the Higgs to gamma gamma collaboration is improving and reorganizing its framework to make it more accessible to outside analyses that build upon it. Examples are the two measurements presented here, these will need to be done later for 13TeV. With the new effort to centralize the framework the production of new measurements will be faster and more efficient.

References: "Observation of the diphoton decay of the Higgs boson and measurement of its properties" EPJC 74 (2014) 3076, CMS note: AN2014_172, HIG-14-016-pas, CMS note: AN2014_032, HIG-14-037-pas.
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