Summary of Activities in 2010 and 2011

Jan Veverka

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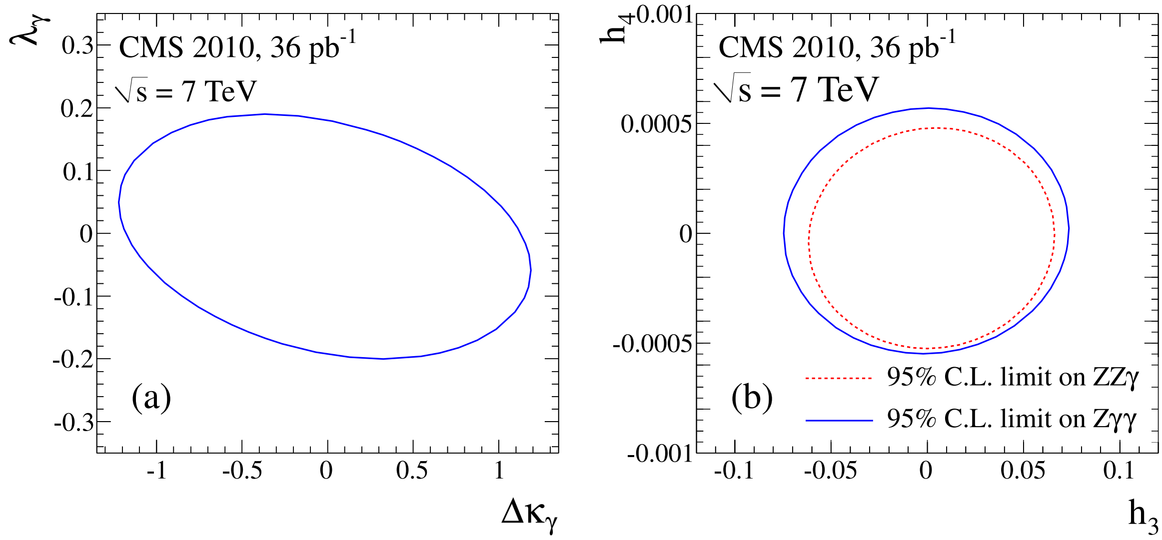

Figure 1: Two-dimensional 95% C.L. limit contours (a) for the WWγ vertex couplings λ_γ and $\Delta\kappa_\gamma$ (blue line), and (b) for the ZZγ (red dashed line) and Z$\gamma\gamma$ (blue solid line) vertex couplings h_3 and h_4.

Observation of Wγ and Zγ Final States

The first measurement of Wγ and Zγ production in proton-proton collisions at $\sqrt{s} = 7$ TeV, based on a data sample recorded by the CMS experiment at the LHC and corresponding to an integrated luminosity of 36 pb^{-1}, is presented. The electron and muon decay channels of the W and Z are used. The total cross sections are measured for photon transverse energy $E_T^\gamma > 10$ GeV and spatial separation from charged leptons in the plane of pseudorapidity and azimuthal angle $\Delta R(\ell, \gamma) > 0.7$, and with an additional dilepton invariant mass requirement of $M_{\ell\ell} > 50$ GeV for the Zγ process. The following cross section times branching fractions are found: $\sigma(pp \to \mathrm{W}\gamma + X) \times \mathcal{B}(W \to \ell\nu) = 55.9 \pm 5.0$ (stat.) $\pm$ 5.0 (syst.) $\pm$ 6.1 (lumi.) pb and $\sigma(pp \to \mathrm{Z}\gamma + X) \times \mathcal{B}(Z \to \ell\ell) = 9.3 \pm 1.0$ (stat.) $\pm$ 0.6 (syst.) $\pm$ 1.0 (lumi.) pb, and these are in agreement with standard model predictions. The first limits on anomalous WWγ, ZZγ, and Z$\gamma\gamma$ trilinear gauge couplings are set at $\sqrt{s} = 7$ TeV, see fig. 1.

There are two main sources of the systematic uncertainties: the amount of background coming from jets faking photons, and the uncertainty on the photon energy scale. We use two independent data-driven methods to estimate the former and Z $\to \mu\mu\gamma$ radiative decays for the latter. To estimate the uncertainty due to the energy scale using data we minimize the negative log likelihood of the $\mu\mu\gamma$ system invariant mass, see fig. 2.

Both of these systematic uncertainties are expected to decrease significantly as we collect more data. Together with decreasing statistically uncertainties and exploring the hard tail of the photn p_T spectrum will enables us to set more stringent aTGC limits than Tevatron using the 2011 data as well as measure the cross-section with higher precision.

- CMS ANALYSIS NOTE AN-10-279
- CMS ANALYSIS NOTE AN-11-88
- CMS PAPER EWK-10-008

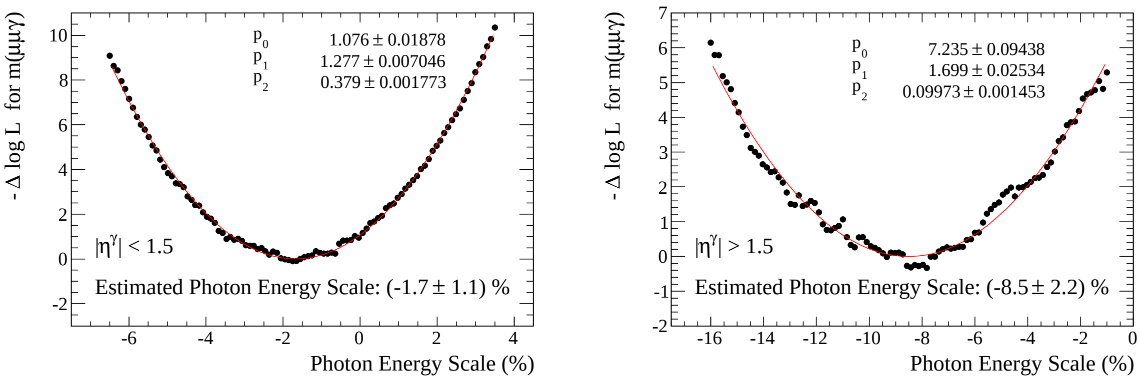

Figure 2: The negative log-likelihood for $x = m_{\mu\mu\gamma}$ as a function of the photon energy scale with a parabolic fit for the EB (left) and the EE (right).

ECAL Resolution

The ECAL resolution has a direct impact on our sensitivity searching for the Higgs boson in the $H \to \gamma\gamma$ channel. We develop monte-carlo based methods to measure it in-situ through the width of the $Z \to ee$ resonance peak. This will be even more crucial during the 2011 data-taking when we expect our Higgs search to start being sensitive.

Photon Pixel Match Veto

Being a great source of in-situ photons, we use the $Z \to \mu\mu\gamma$ radiative decays not only to study the photon energy scale but also the photon identification. Many properties of the photons can be studied using the electrons from $Z \to ee$ events. This is not the case for the pixel match veto - a binary quantity used to distingish electrons from photons by searching for a presence of a matching electron track seed in the pixel detector. We perform the first measurement of this quantity using the tag-and-probe technique tagging with the di-muon pair and probing with the photon, see fig. 3. This measurement is currently limited by low statistics and it will benefit greatly from the larger 2011 dataset. Our pixel match veto efficiency measurement has a direct impact on all analysis with isolated photons.

- CMS ANALYSIS NOTE AN-11-89
- CMS PAPER QCD-10-037 Isolated photon production.

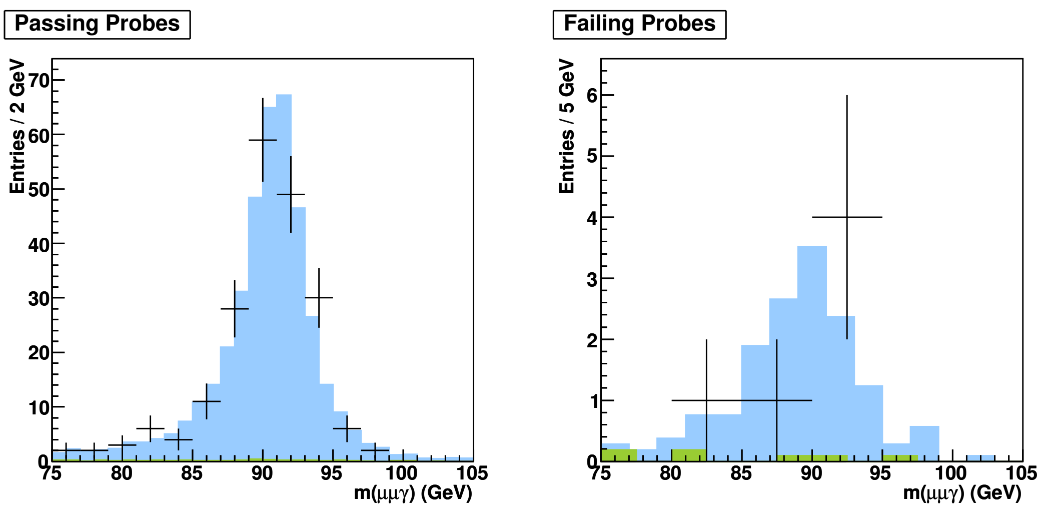

Figure 3: The $\mu\mu\gamma$ system invariant mass spectrum for the pixel match veto passing (left) and failing (right) probes. 2010 data is overlayed over simulated events for the ECAL Barrel.