EPA and absorption corrections

EPA assumes **full** factorization of the long range (-> photon fluxes) and short range (-> $\gamma\gamma$ fusion) physics; values of the impact parameter b are the best check of a regime one works with – they are different for the proton elastic and dissociative cases, though the flux **b** dependence is similar, $dn \propto bdb$.

If one takes the 8 TeV beam and x=0.01 (corresponding to W=160 GeV) than:

Elastic: $b_{max} \approx 20$ fm and $b_{min} \approx 0.6$ fm

Inelastic (dissociative): typ. $b_{max} \approx 0.1$ fm and $b_{min} \approx 0.01$ fm

For two-photon exchange one deals with two impact parameters, so one can approximate $b \approx b_1 + b_2$

EPA and absorption corrections

For two-photon exchange one deals with two impact parameters, hence one can approximate $b \approx b_1 + b_2$

Therefore, relatively <u>small</u> absorption are expected both for fully exclusive (elastic-elastic) as well as single dissociative SD (2x elastic-inelastic) and **BIG** one for DD case (inelastic-inelastic)

Three important comments regarding two-photon lepton pair production:

- Lepton acoplanarity is a good measure of the relevant impact parameters involved; if there is significant absorption it must distort the acoplanarity

- Absorption should increase with increase of W (since b_{max} decreases)

- Fully exclusive pairs die fast with increasing pair pT; so above 1 GeV/c one is left with SD+DD only

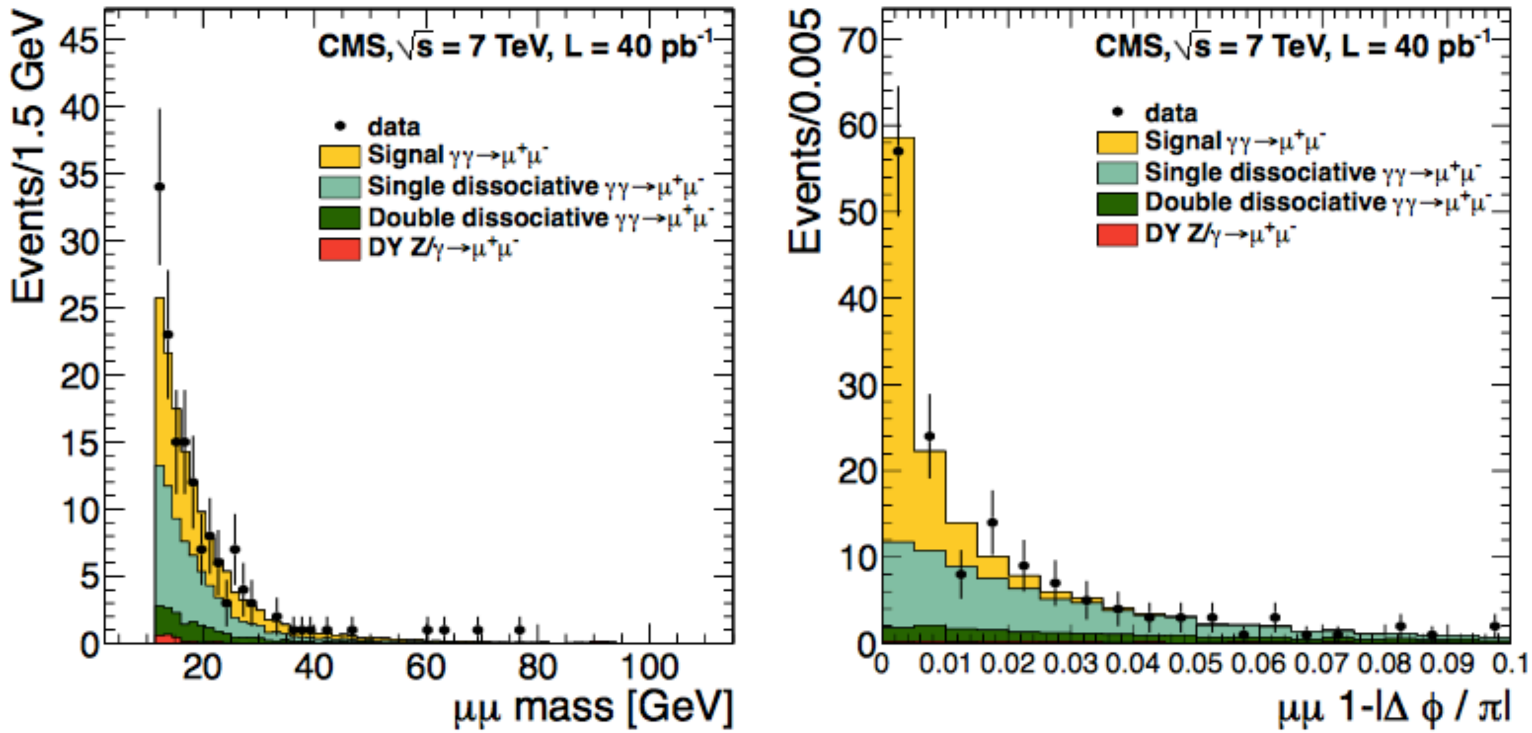


Figure 7: Muon pair invariant mass spectrum (left) and acoplanarity (right), with all selection criteria applied and the simulation normalized to the best-fit value. Data are shown as points with statistical error bars, while the histograms represent the simulated signal (yellow), single (light green) and double (dark green) proton dissociative backgrounds, and DY (red).

data-theory signal ratio: $R_{El-El} = 0.83^{+0.14}_{-0.13}$;

single-proton dissociation yield ratio: $R_{diss-El} = 0.73^{+0.16}_{-0.14}$;

Observe some deficiency but within stat.+syst. errors, without clear hint for absorptive effects in fully exclusive case

EPA and γγ -> WW

Summary for the dilepton (semi-)exclusive production:

No evidence for strong absorption in elastic-elastic production; also above 160 GeV

- LPAIR, which is "mirrored" by EPA calculations, describes well both acoplanarity and invariant mass (W) distributions
- DD seems to be almost completely suppressed! Proper modeling of the DD is essential for further detailed studies of the absorptive corrections.

S O L U T I O N for getting a proper γγ-> WW from pp –> pWWp(*) as proposed and applied by CMS (and followed recently by ATLAS):

This is a data-driven F factor (in 2011) which "automatically" takes into account the absorptive effects:

$$F = \left.\frac{N_{\mu\mu\ \mathrm{data}} - N_{\mathrm{DY}}}{N_{\mathrm{elastic}}}\right|_{m(\mu^+\mu^-)>160\,\mathrm{GeV}}.$$

$$F = 3.23 \pm 0.53.$$

The basic assumption there (backed by the data) is that the absorptive corrections are NOT strongly changing with W

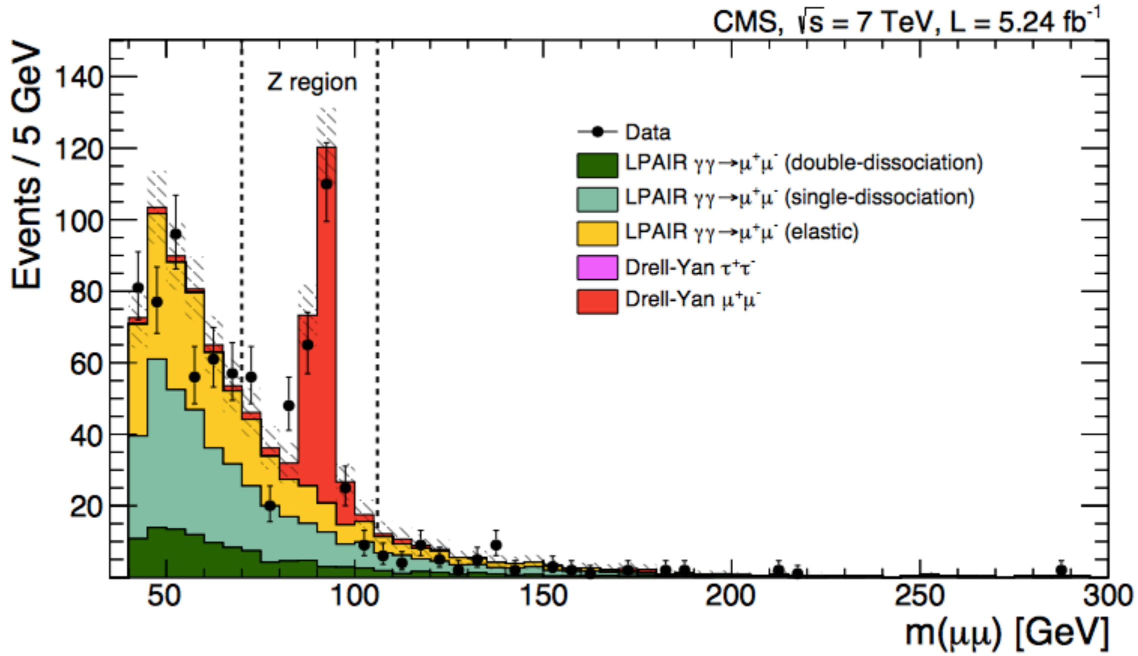
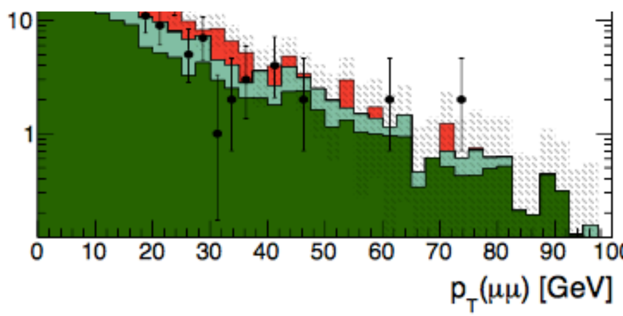


Figure 3: Invariant mass distribution of the muon pairs for the elastic selection with no additional track on the dimuon vertex. The dashed lines indicate the Z-peak region. The hatched bands indicate the statistical uncertainty in the simulation.

Region	Data	Simulation	Data/Simulation
Elastic	820	906 ± 9	0.91 ± 0.03
Dissociation	1312	1830 ± 17	0.72 ± 0.02
Total	2132	2736 ± 19	0.78 ± 0.02



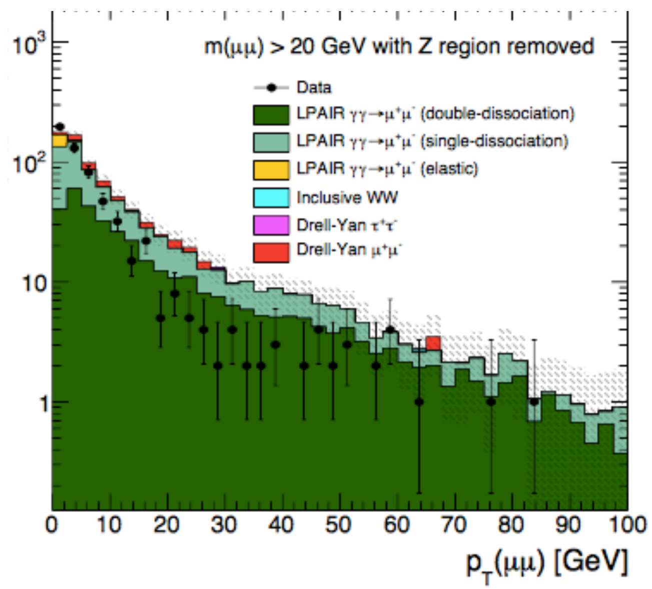


Figure 6: Transverse momentum distribution for $\mu^+\mu^-$ pairs with zero extra tracks passing the dissociation selection, for the Z region only (left), and with the Z region removed (right). The hatched bands

8 TeV update

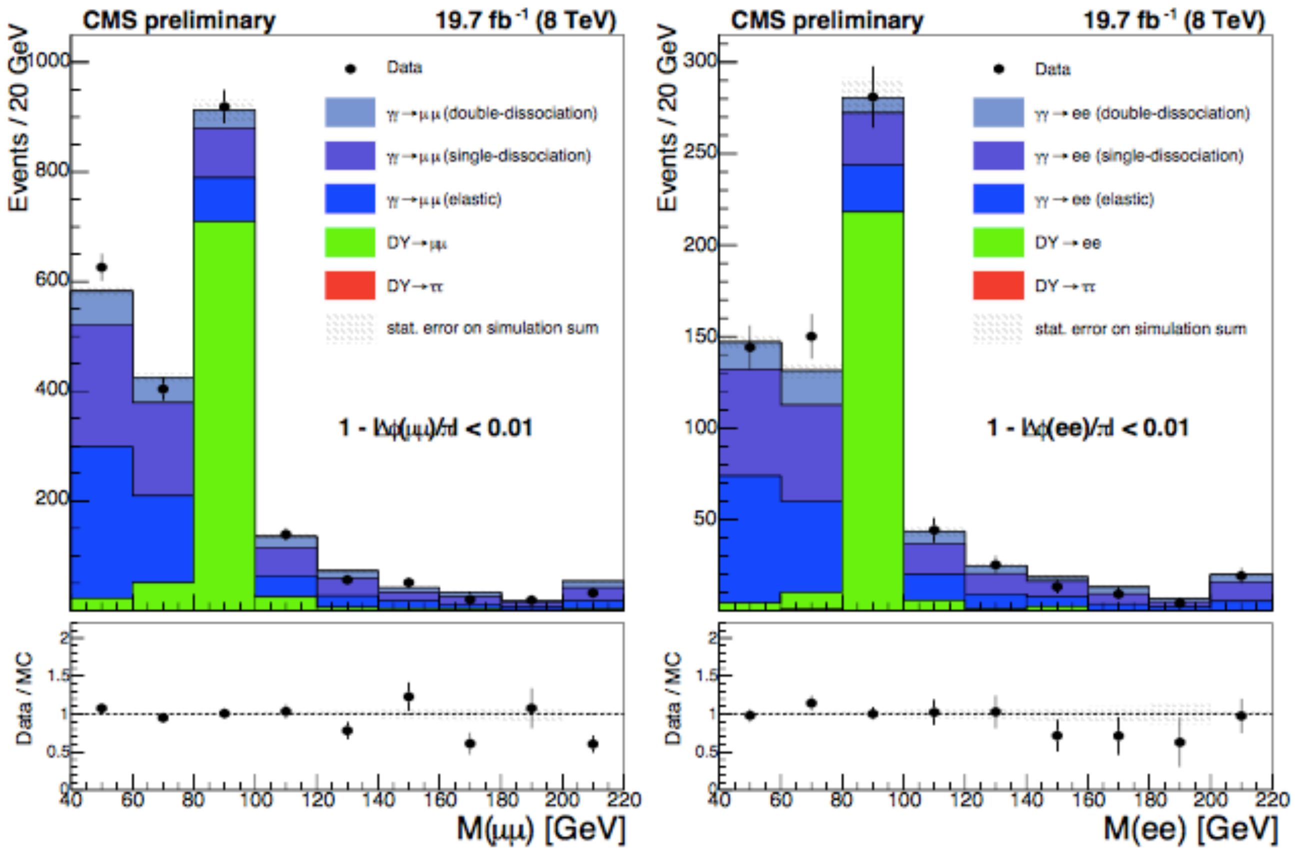


Figure 3: The dilepton invariant mass for the $\mu^+\mu^-$ (left) and e^+e^- (right) final states in the elastic $\gamma\gamma \rightarrow \ell^+\ell^-$ control region. The exclusive simulation is scaled to the number of events in data for $m(\ell^+\ell^-) < 70$ GeV or $m(\ell^+\ell^-) > 106$ GeV. The Drell-Yan simulation is scaled to the number of events in data for $m(\ell^+\ell^-) > 70$ GeV or $m(\ell^+\ell^-) < 106$ GeV The last bin in both plots is an overflow bin and includes all events with invariant mass greater than 220 GeV.

8 TeV update

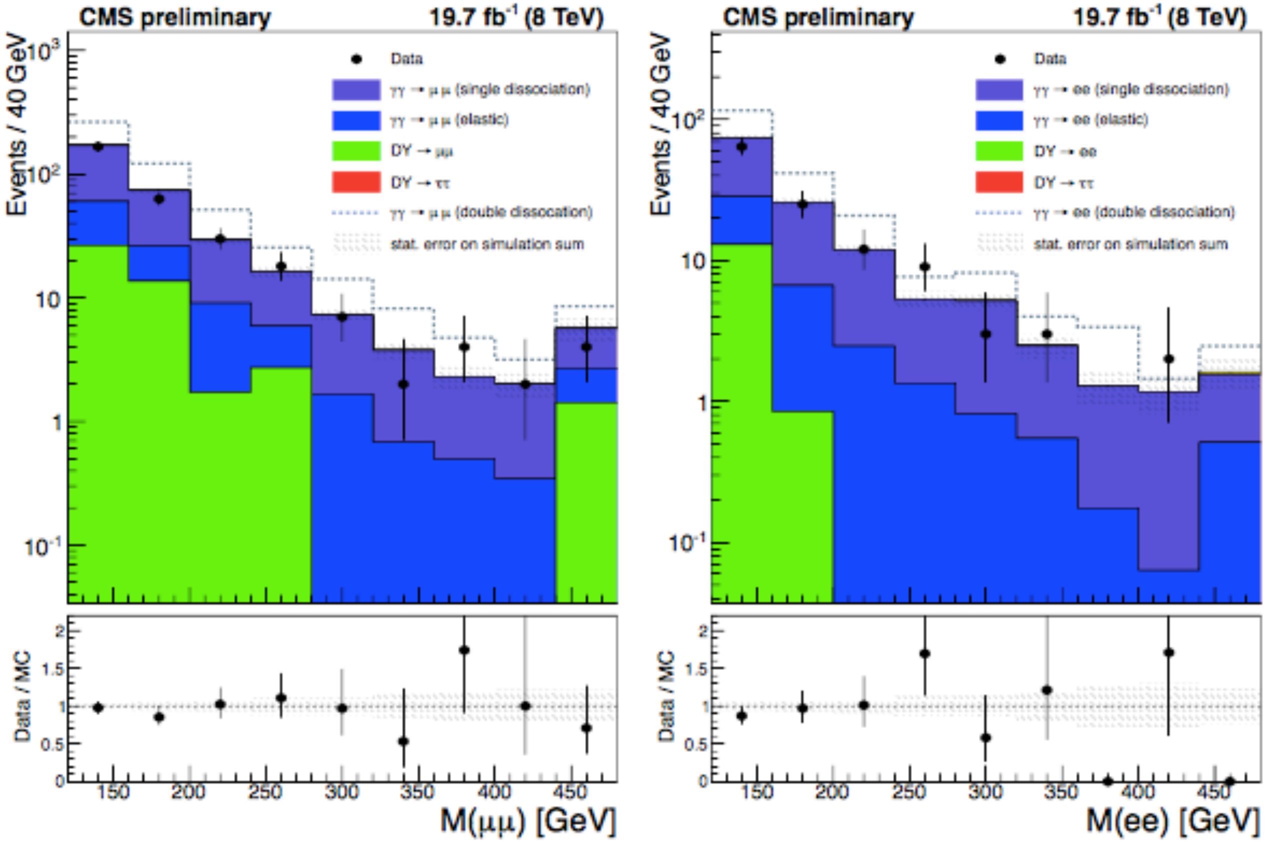


Figure 4: The dilepton invariant mass for the $\mu^+\mu^-$ (left) and e^+e^- (right) final states in the $\gamma\gamma \to \ell^+\ell^-$ proton dissociation control region with 0 additional tracks associated to the dilepton vertex. The efficiency correction has been applied to the exclusive samples. The double-dissociation contribution in the simulation is much too large because of rescattering effects. Therefore, the double-dissociation contribution is not included in the ratio plot and is shown as the blue dotted line on top of the sum of the simulation. The region $m(\ell^+\ell^-) > 160$ GeV is used to obtain the proton dissociation contribution. The last bin is an overflow bin and includes all events above 480 GeV.

EPA and $\gamma\gamma$ -> WW

The basic assumption there (backed by the data) is that the absorptive effects are NOT changing fast; in practice, it was tested by calculating F factor for increased threshold values, above 160 GeV – up to about 400 GeV we see no clear trend, just (rather small) statistical fluctuations which have been included into systematic errors

BOTTOM LINE:

The $\gamma\gamma$ -> WW cross-sections measured (correctly) by CMS have no bias due to (not well known) absorption and the corresponding uncertainties of our data-driven procedure of extracting the proper $\gamma\gamma$ -> WW are included in syst. errors.