Exclusive production at CMS

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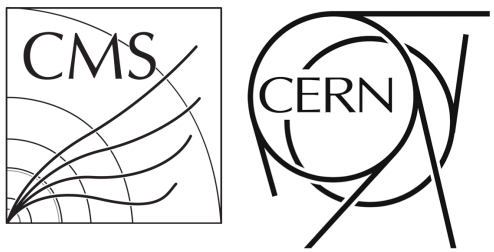
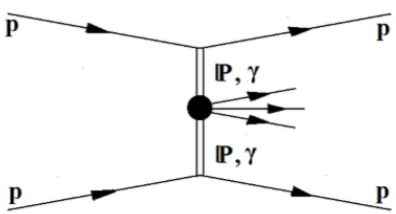
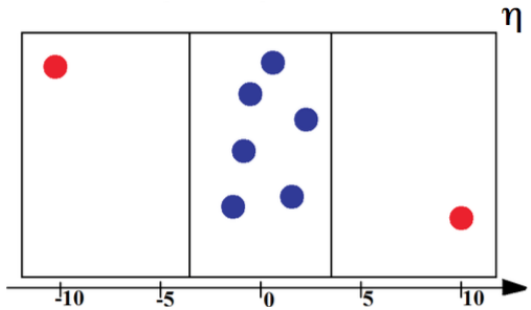


Contents

General concepts

Central Exclusive Production: a unique QCD process in which particles are produced via colourless propagators

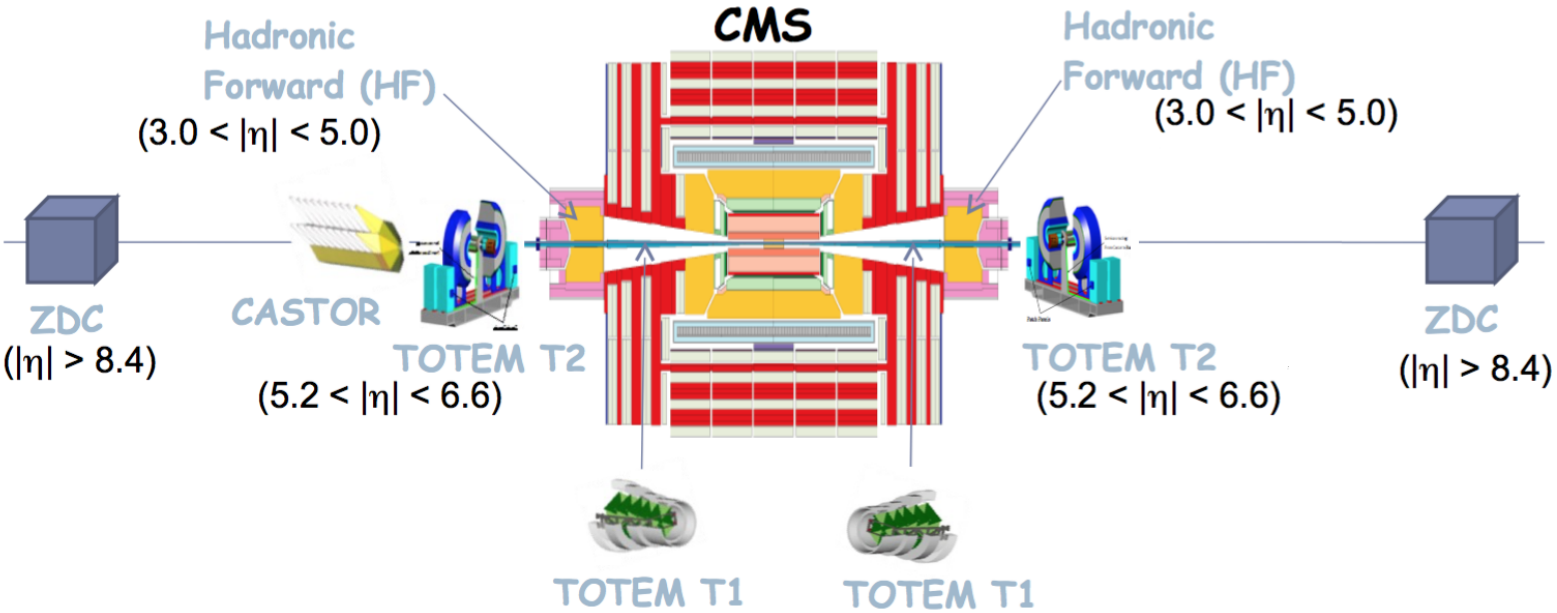




Central Production (CP)

- Activity in the central part
- No activity in forward-backward
- Protons in very forward detectors
- No pomeron remnants

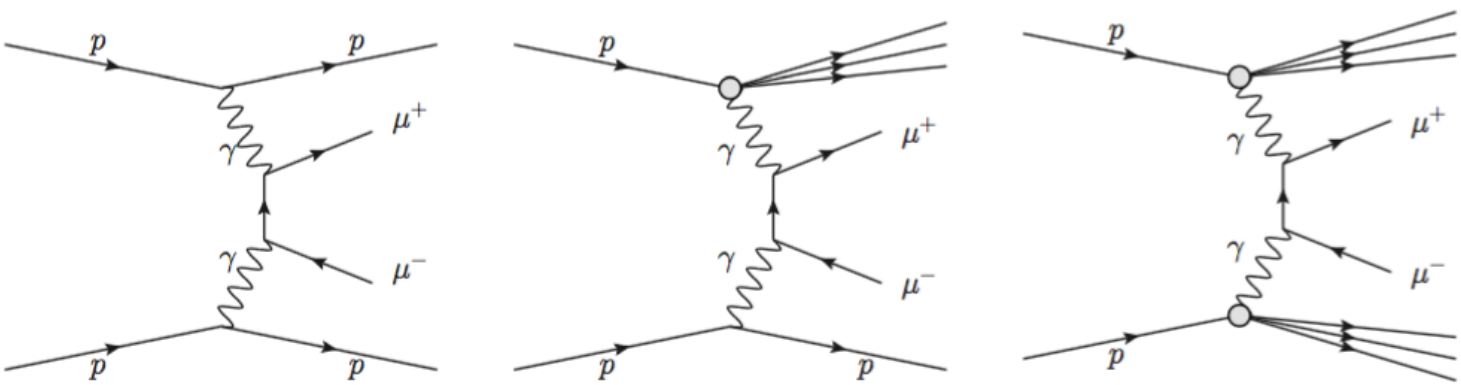
Detector



Broad coverage in pseudorapidity

Introduction – diagrams

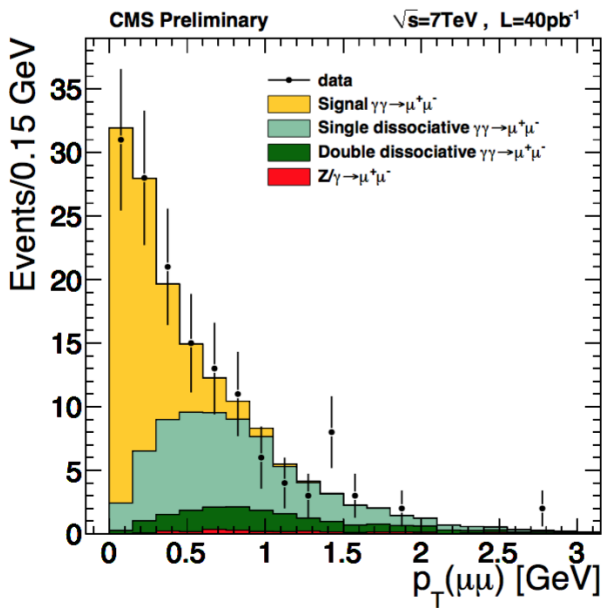
- Measurement of exclusive $\gamma\gamma \to \mu^+\mu^-$ production at $\sqrt{s} = 7$ TeV, 2011, CMS-PAS-FWD-10-005
- luminosity: 40 pb^{-1}, 2010 data, 80% of events with pileup > 1



Kinematic selection

Selection	Data	Signal	p diss.	Double p diss.	DY	Sum
Trigger	7.87M	301.4	522.9	276.8	54563	55664
Vertex + Track-exclusivity	921	246.9	436.9	197.1	55.9	936.8
Muon ID	724	193.4	335.5	159.6	52.8	741.3
$p_T > 4$ GeV, $\|\eta\| < 2.1$	438	131.7	240.8	106.4	19.7	498.6
$m(\mu\mu) > 11.5$ GeV	270	94.5	187.3	85.8	12.5	380.1
$3D$ angle $< 0.95\pi$	257	87.2	178.4	83.3	12.1	361.0
$1 - \|\Delta\phi/\pi\| < 0.1$	203	87.2	126.2	41.0	8.3	262.7
$\|\Delta p_T\| < 1.0$ GeV	148	86.4	78.6	16.1	2.7	183.8

The histograms are the result of fitting the MC to the data:

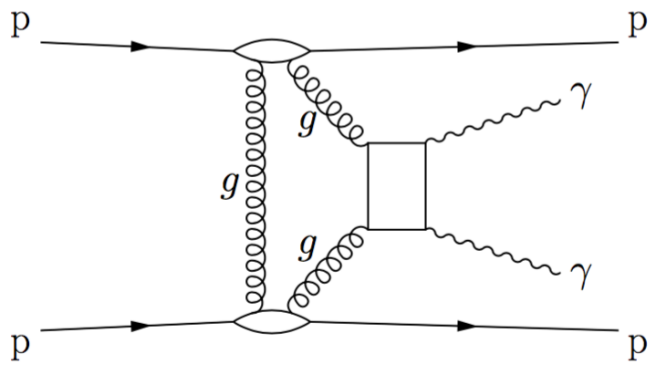


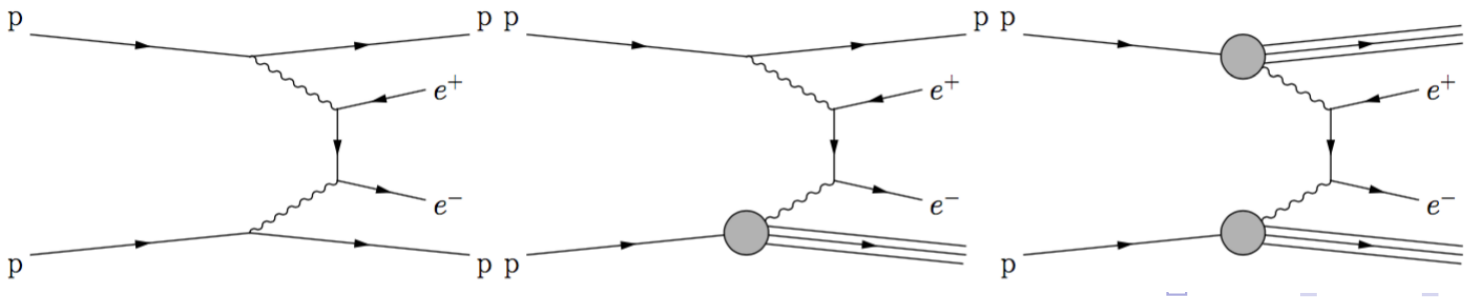
Results

- The resulting visible cross-section from a fit to the $p_T(\mu^+\mu^-)$ distributionis $\sigma(pp \to p\mu^+\mu^-p) = 3.38^{+0.58}_{-0.55}(\text{stat.}) \pm 0.16(\text{syst.}) \pm 0.14(\text{lumi})$ pb.
- The corresponding ratio to the predicted value is $0.83^{+0.14}_{-0.13}(\text{stat.}) \pm 0.04(\text{syst.})$.

Introduction – diagrams

- Search for central exclusive $\gamma\gamma$ production and observation of central exclusive e^+e^- production in pp collisions at $\sqrt{s} = 7$ TeV, 2012, CMS-PAS-FWD-11-004
- pp collisions at $\sqrt{s} = 7$ TeV using a data sample collected in 2010. The corresponding integrated luminosity is 36 pb^{-1}.





Event selection summary

Number of diphoton (dielectron) candidates remaining after each selection step:

exclusive diphoton analysis		exclusive dielectron analysis	
selection criterion	events remaining	selection criterion	events remaining
Trigger	3 023 496	Trigger	3 023 496
Photon reconstruction	1 683 526	Electron reconstruction	132 271
Photon identification	40 692	Electron identification	2 648
Cosmic ray rejection	32 775	Cosmic ray rejection	2 023
Exclusivity requirement	0	Exclusivity requirement	17

Predicted numbers of dielectron events to be observed:

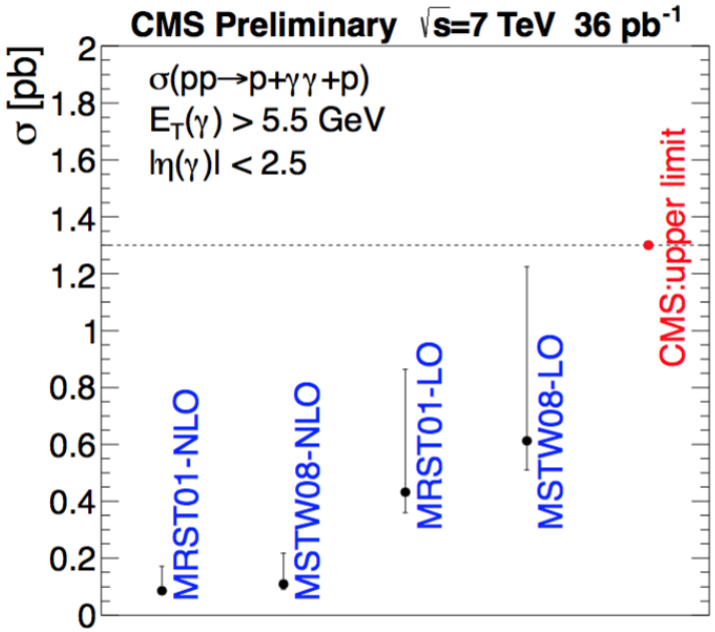
Process	$\mathcal{L}$	σ	ε	nEvents
el-el	$36 \pm 1.4\,\mathrm{pb}^{-1}$	3.74 ± 0.04 pb	0.0488 ± 0.0056	6.57 ± 0.07 (theo.) ± 0.80 (syst.)
inel-el	$36 \pm 1.4\,\mathrm{pb}^{-1}$	3.34 ± 0.67 pb $\times 2$	0.0348 ± 0.0035	8.37 ± 1.68 (theo.) ± 0.90 (syst.)
inel-inel	$36 \pm 1.4\,\mathrm{pb}^{-1}$	3.52 ± 0.70 pb	0.0119 ± 0.0011	1.51 ± 0.30 (theo.) ± 0.15 (syst.)
Total				16.5 ± 1.7 (theo.) ± 1.2 (syst.)

Results

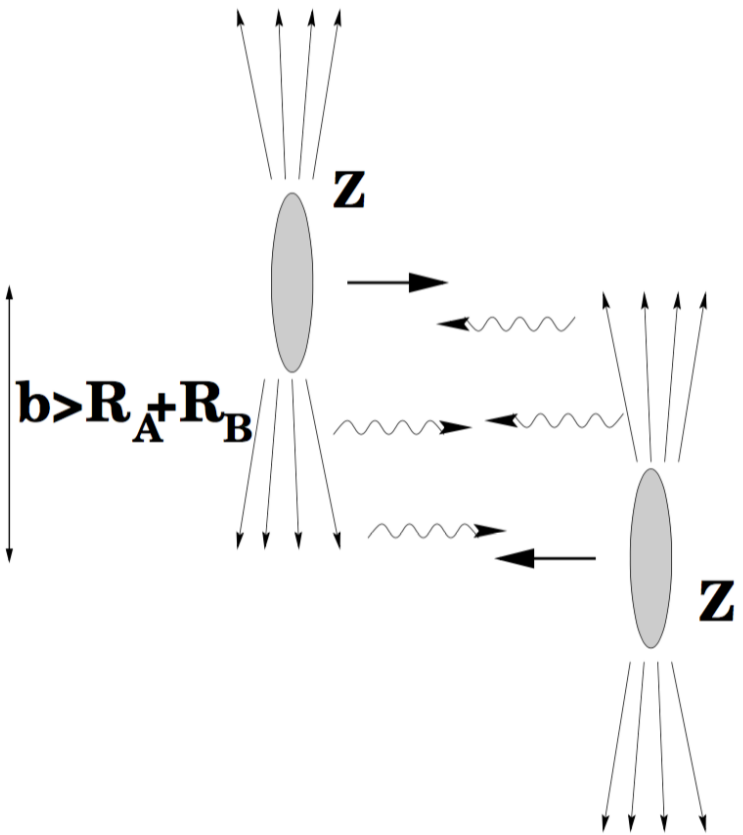
Upper limit on the production cross section at 95% confidence level:

$$\sigma^{E_T(\gamma)>5.5\,\mathrm{GeV},\,|\eta(\gamma)|<2.5}_{\text{exclusive }\gamma\gamma\text{ production}} < 1.30\ \mathrm{pb}$$

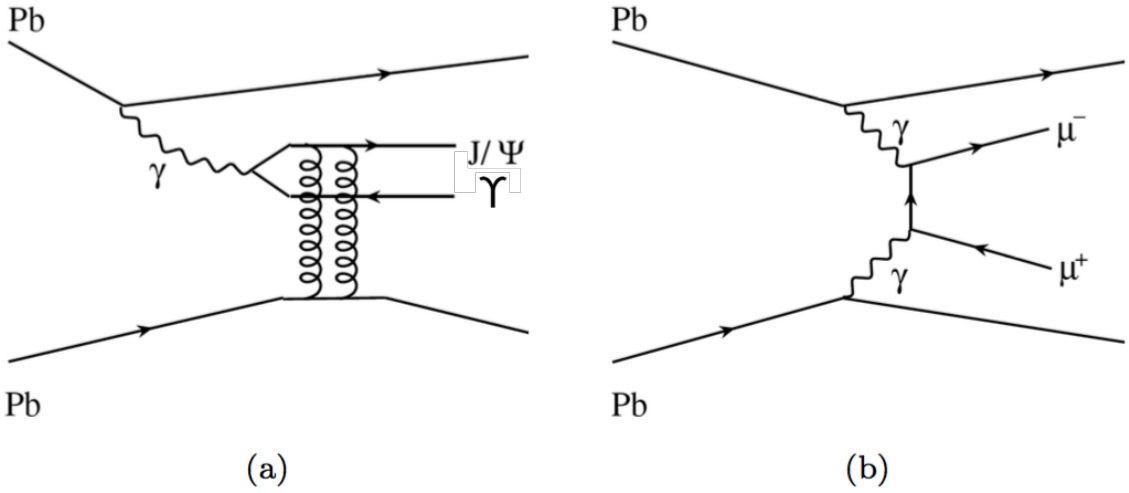
Comparison of the cross section between the measurement and four different theoretical predictions:



Ultra–Peripheral Collisions (UPC)



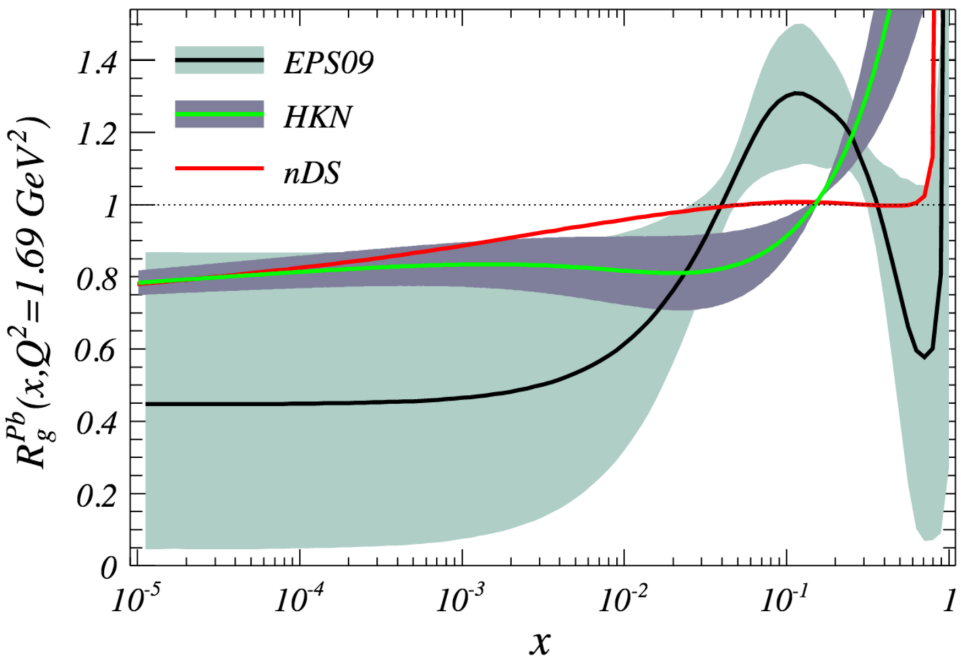
UPC photoproduction



Analysis: Υ photoproduction in UPC events during HI collisions

Nuclear Shadowing

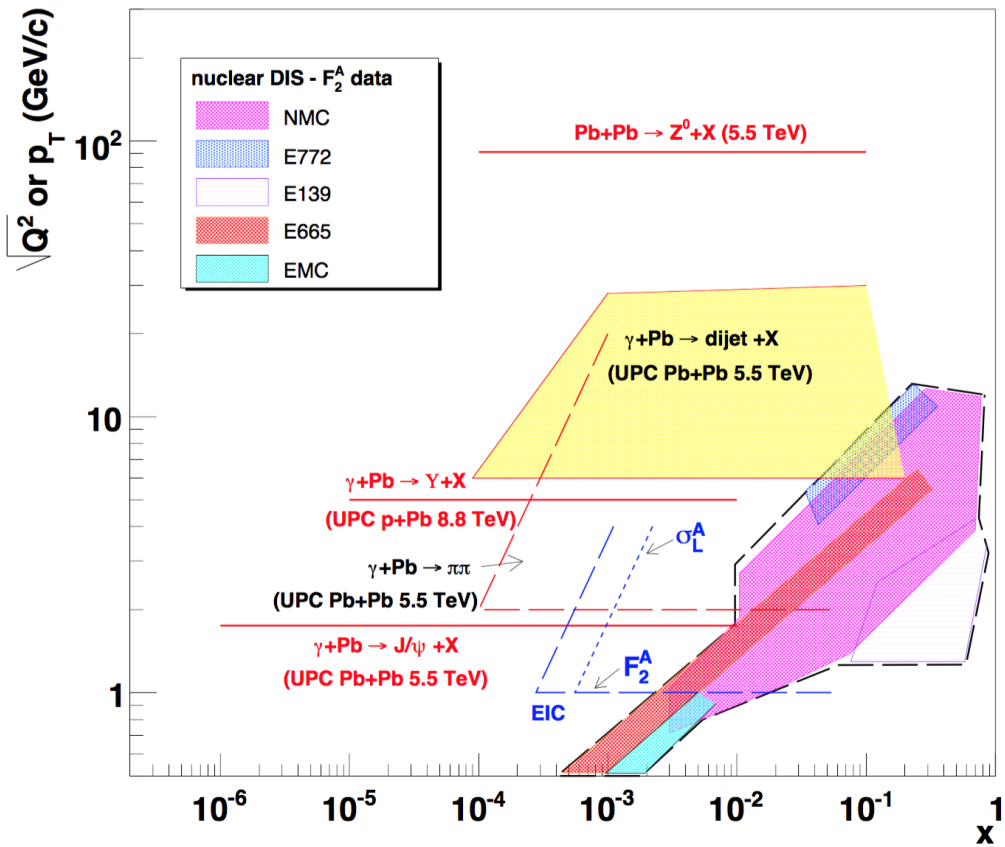
Current knowledge of nuclear PDFs, shown as the ratio of bound over free proton gluon distributions. Shadowing regions can be seen for $x < 0.01$. Plot for $Q^2 = 1.69\text{GeV}^2$:



From J.Phys. G39:015010, 2012.

Υ photoproduction

The kinematic range in which UPCs at the LHC can probe gluons in protons and nuclei:



From Phys.Rept. 458:1–171, 2008

Υ photoproduction in Run–2