



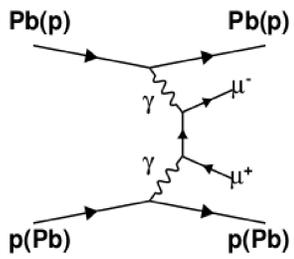
Exclusive photoproduction of $\mu\mu$ -pairs in pPb collisions at 5.02 TeV per nucleon



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Introduction



Di-lepton production in photon-photon collisions is a benchmark process that allow for precise determination of the luminosity at the LHC. In particular in collisions where at least one of the nuclei is a lead nucleus, the photon fluxes are large enough to make efficient use of it. In this analysis dimuon production during the pPb run in 2013 is analyzed using dedicated triggers. Any hadronic contribution is removed by stringent exclusivity requirements. Yields of selected dimuon events are compared to high precision theoretical calculations of electromagnetic particle production from photon-photon collisions in the very periphery of the colliding nuclei.

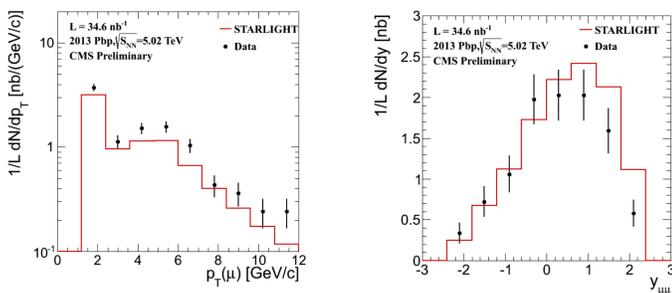
Data Sample and Event Selection

- Data Taking:**
Analysis is based on the the pA run 2013, $\int L dt = 34.6 \text{ nb}^{-1}$ (Van der Meer Scan).
- STARLIGHT MC¹⁾:**
The STARLIGHT event generator is used to produce samples of two-photon production of muon pairs. The invariant mass ranges: 4-100 GeV/c^2 ($\sim 1.4 \text{ mb}$).
- Event Selection:**
Invariant mass of the pair between 4.5 and 99.5 GeV/c^2 (excluding Upsilon in 8-12 GeV/c^2).

¹⁾Baltz, Gorbunov, Klein, Nystrand, Phys.Rev. C80 (2009) 044902

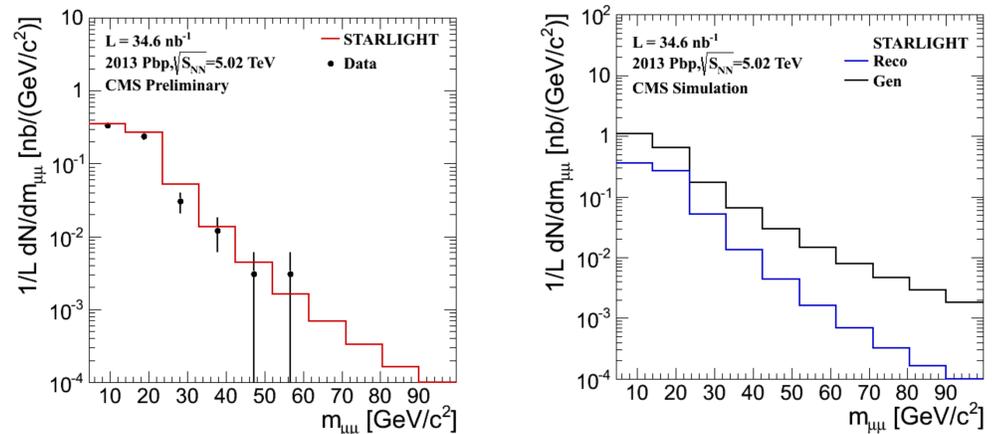
Exclusivity

- Calorimeter exclusivity:**
Tower matched two muons excluded and no additional towers above noise in Calorimeter.
- Muon exclusivity:**
 $|\Delta\phi(\mu^+ \mu^-)| > 2.8$;
 $|\Delta p_T(\mu^+ \mu^-)| < 1.0 \text{ GeV}/c$ and $0.05 < p_T < 0.3 \text{ GeV}/c$.
Two reconstructed tracks.
- Muon selection:**
Single muon track $|\eta| < 1.8$, $p_T > 3 \text{ GeV}/c$.



Analysis

In this analysis the cross-section is defined in the region of 4.5 to 99.5 GeV/c^2 of the dimuon invariant mass. To determine the efficiency of detecting a dimuon system with an invariant mass $m_{\mu\mu}$, the Starlight Monte Carlo sample (generator-level, 'Gen') is folded with the CMS detector resolution (reconstructed-level, 'Reco') using the CMS software framework.



Results

Method to Derive Luminosity

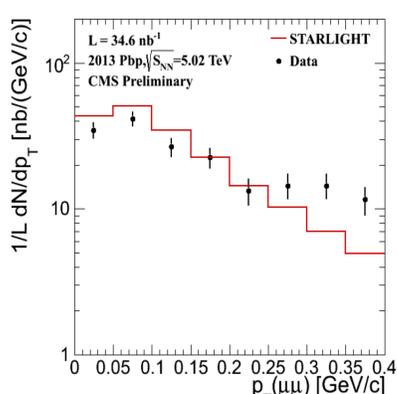
The measurement of luminosity is used as the following,

$$\mathcal{L}(\gamma\gamma \rightarrow \mu\mu) = \frac{N_{Data}^{\mu\mu}}{\epsilon^{\mu\mu} \times \sigma_{\gamma\gamma \rightarrow \mu\mu}} = (30.4 \pm 2.2(stat.) \pm 3.9(syst.)) \text{ nb}^{-1}$$

$N_{Data}^{\mu\mu}$ = Number of selected dimuon events

$\epsilon^{\mu\mu} = N_{Reco} / N_{Gen}$ efficiency from simulation

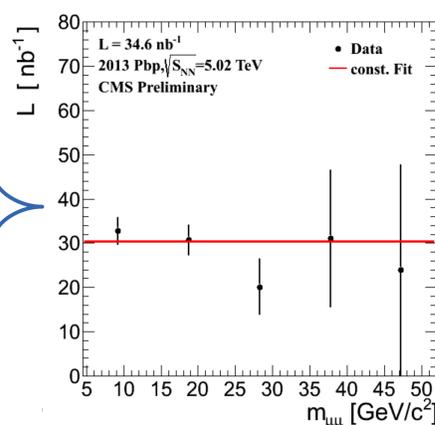
$\sigma_{\gamma\gamma \rightarrow \mu\mu}$ = Cross-section for STARLIGHT



Please note that the luminosity given in the legend ($L=34.6 \text{ nb}^{-1}$) refers to the luminosity determination by van der Meer scans.

The number is compatible with this result within the combined statistical and systematical uncertainties. Systematic uncertainties are estimated by varying the dimuon p_T selection.

The lower boundary was varied from 0.05 GeV/c to 0 GeV/c and the upper boundary from 0.3 GeV/c to 0.4 GeV/c .



Luminosity derived by dividing the efficiency-corrected number of selected dimuon events by the predicted cross-section of STARLIGHT as a function of the dimuon mass.

The red line is a constant fit to the data from this measurement. With a χ^2/ndf of 3.27/4, the luminosity is shown to be independent of the dimuon mass. The fit yields luminosity of 30.4 nb^{-1} with a statistical uncertainty of 2.2 nb^{-1} .

Summary:

- Exclusive dimuon events selected in pPb dataset up to highest masses.
- The control plots show: data – MC comparison is good.
- Dimuon cross section used to determine luminosity.
- Consistency to pPb van der Meer luminosity measurement checked.