Measurement of the Drell-Yan Cross Section in pp collisions at 7 TeV

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Abstract

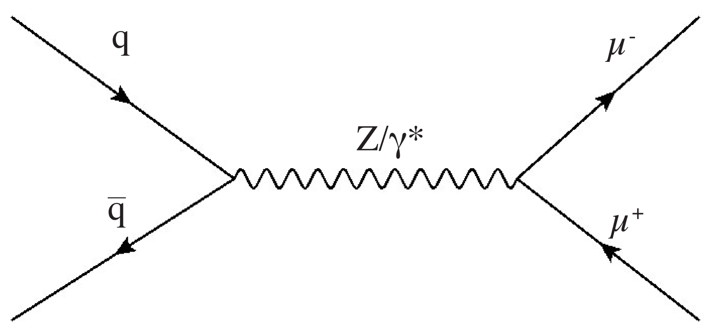
The measurement of the Drell-Yan cross section, dσ/dM, for pp collisions at 7 TeV is presented. Data collected by the CMS Collaboration are used, amounting to 36 pb^{-1}. The mass spectrum ranges from 15 through 600 GeV and is corrected for contamination, resolution, efficiency and acceptance. Results are compared to theoretical calculations and may serve to constrain the PDFs.

Motivation and Theory

The Drell-Yan (DY) process is described in the Standard Model as an s-channel exchange of a Z/γ*. We measure dσ/dM because the DY process is a background for top quark and di-boson measurements, as well as searches for new physics. We measure dσ/dM and compare the results to theory where the DY process is well-established up to next-to-leading-order and next-next-to-leading-order (NNLO). At this stage, we are only working in the di-muon channel.

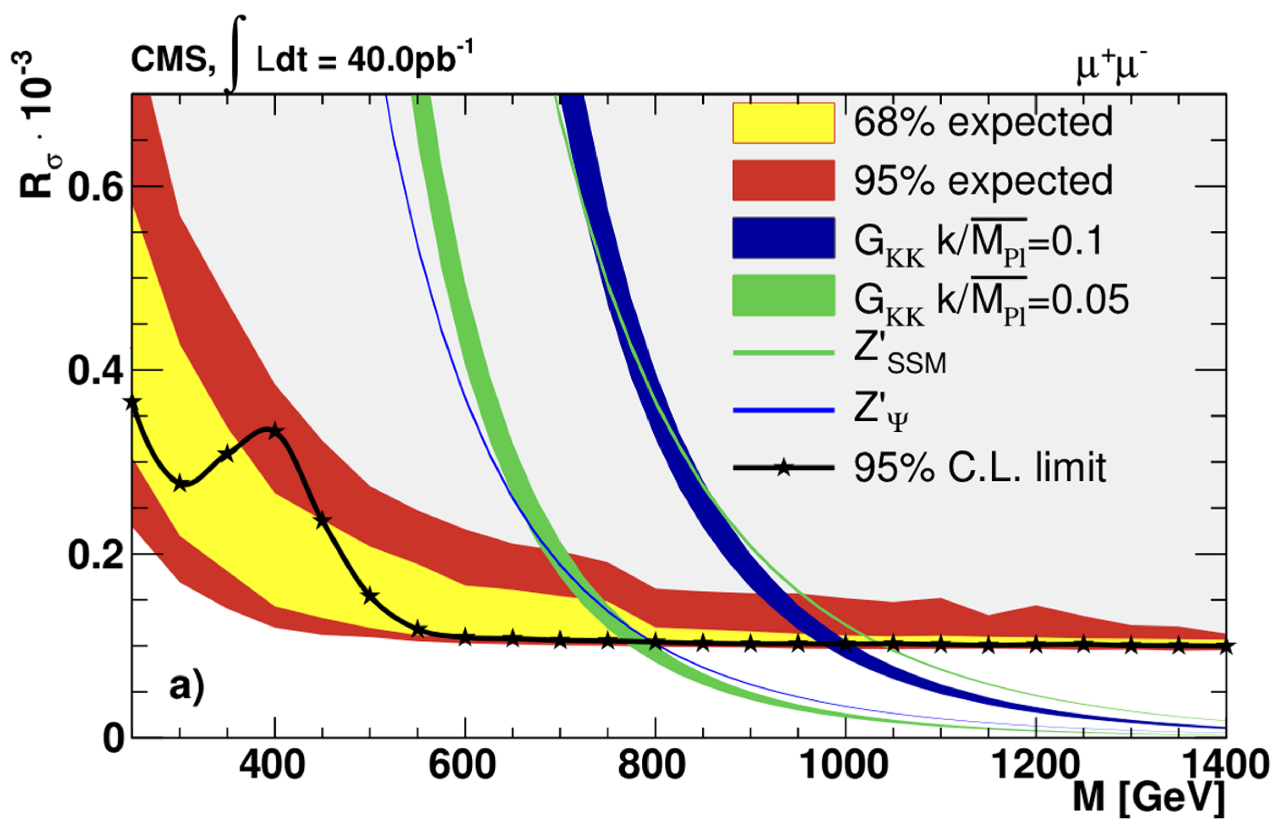
The measured cross section for each bin is computed as: $\sigma_i = N_i / A_i \varepsilon_i C^{FSR} L$; N is the number of observed events, A is acceptance, ε is efficiency, C is the FSR correction factor and L is the integraged luminosity. To reduce known and unknown systematic uncertainties, we measure the cross section in each bin as a ratio with respect to Z peak cross section as measured between 60 and 120 GeV/c^2.

Final State Radiation (FSR) photons are not included in the di-muon invariant mass calculation. This leads to a characteristic tail in the lower di-muon masses or the raw spectrum. A correction is applied after unfolding the resolution function.

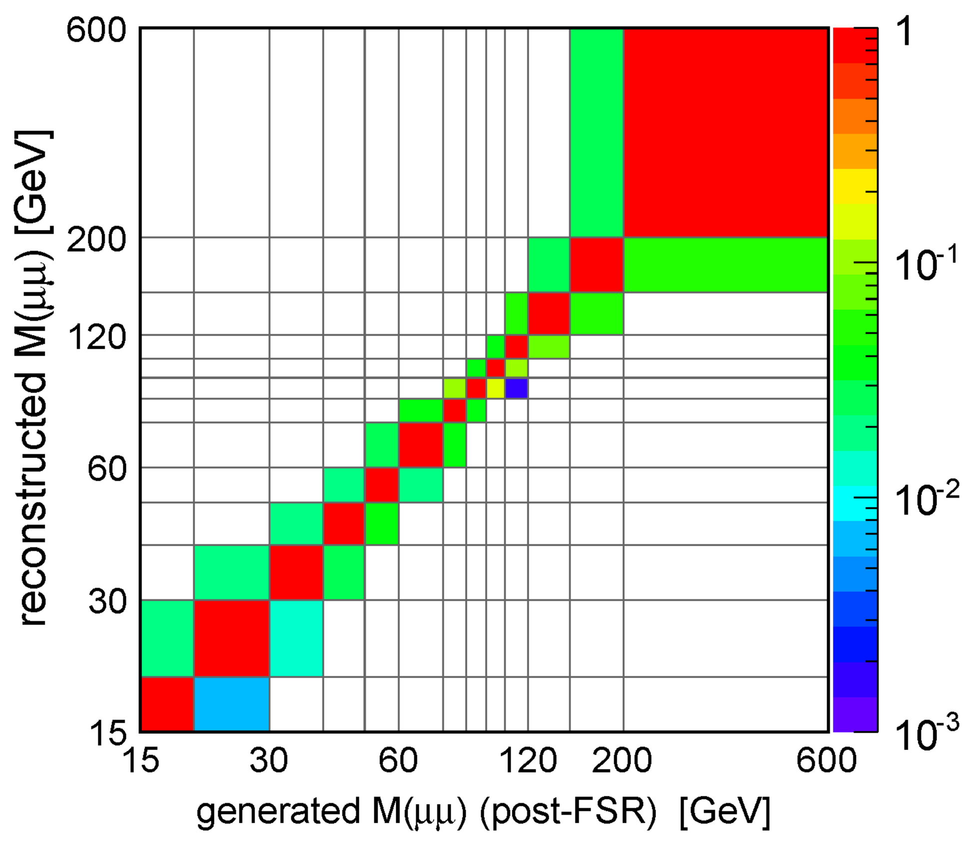


Limits on New Resonances

Limits on new physics resonances with the di-muon channel in the high-mass tail of the Drell-Yan continuum. The search is model independent, but "standard candle" models for theoretical Z′ and Kaluza-Klein Graviton models are represented for limits on new physics. The di-muon resonance search was performed in terms of the cross-section ratio with the Z peak cross section as the denominator.

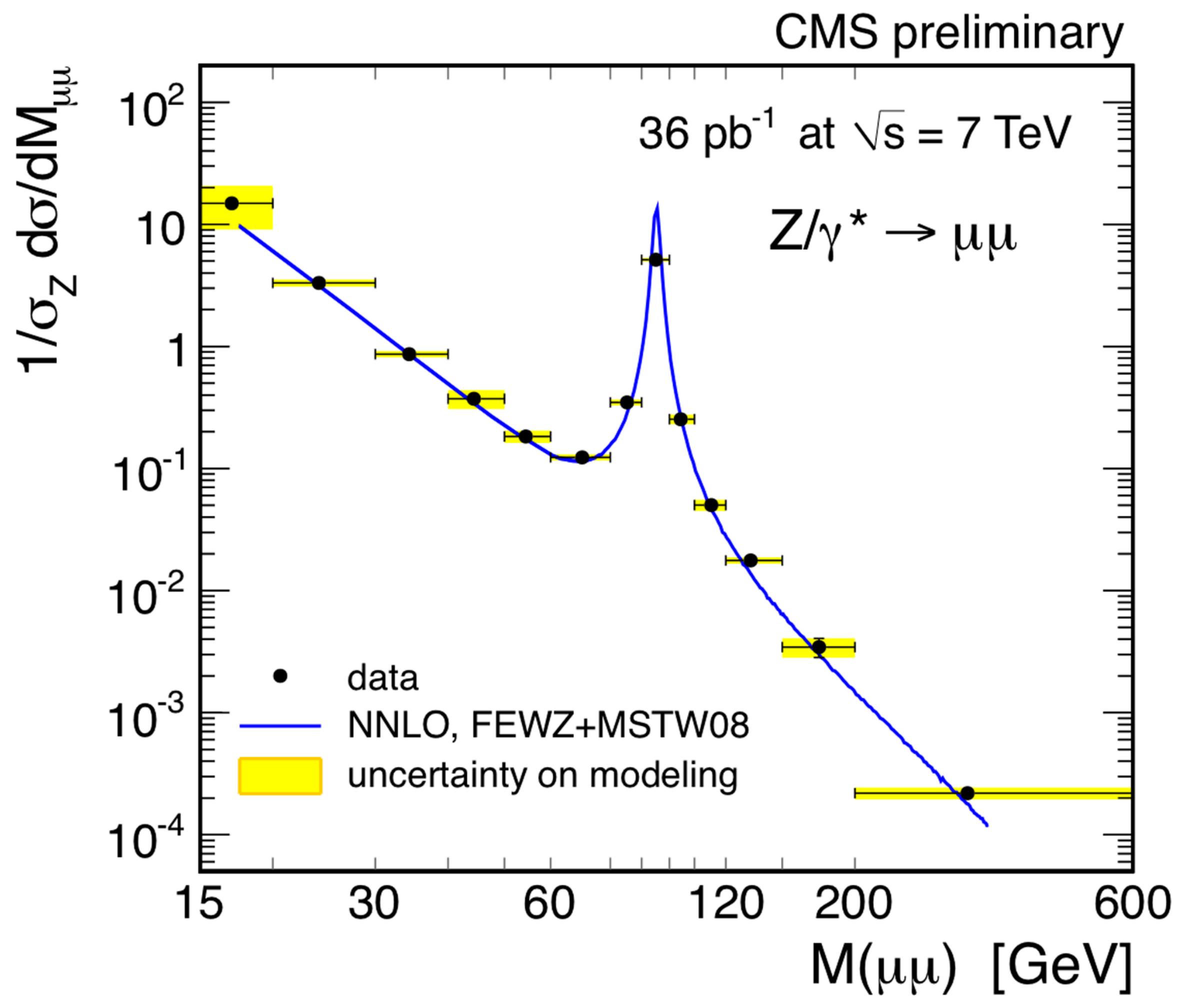


Unfolding the Resolution Function



Detector resolution effects are removed by applying an unfolding method to the observed invariant mass spectrum. The method consists of transforming a matrix to recover the original spectrum such that $N^i_{TRUE} = M^{ij} N^j_{OBS}$. The matrix, M, is derived from post-FSR simulation with data-driven resolution corrections.

Results

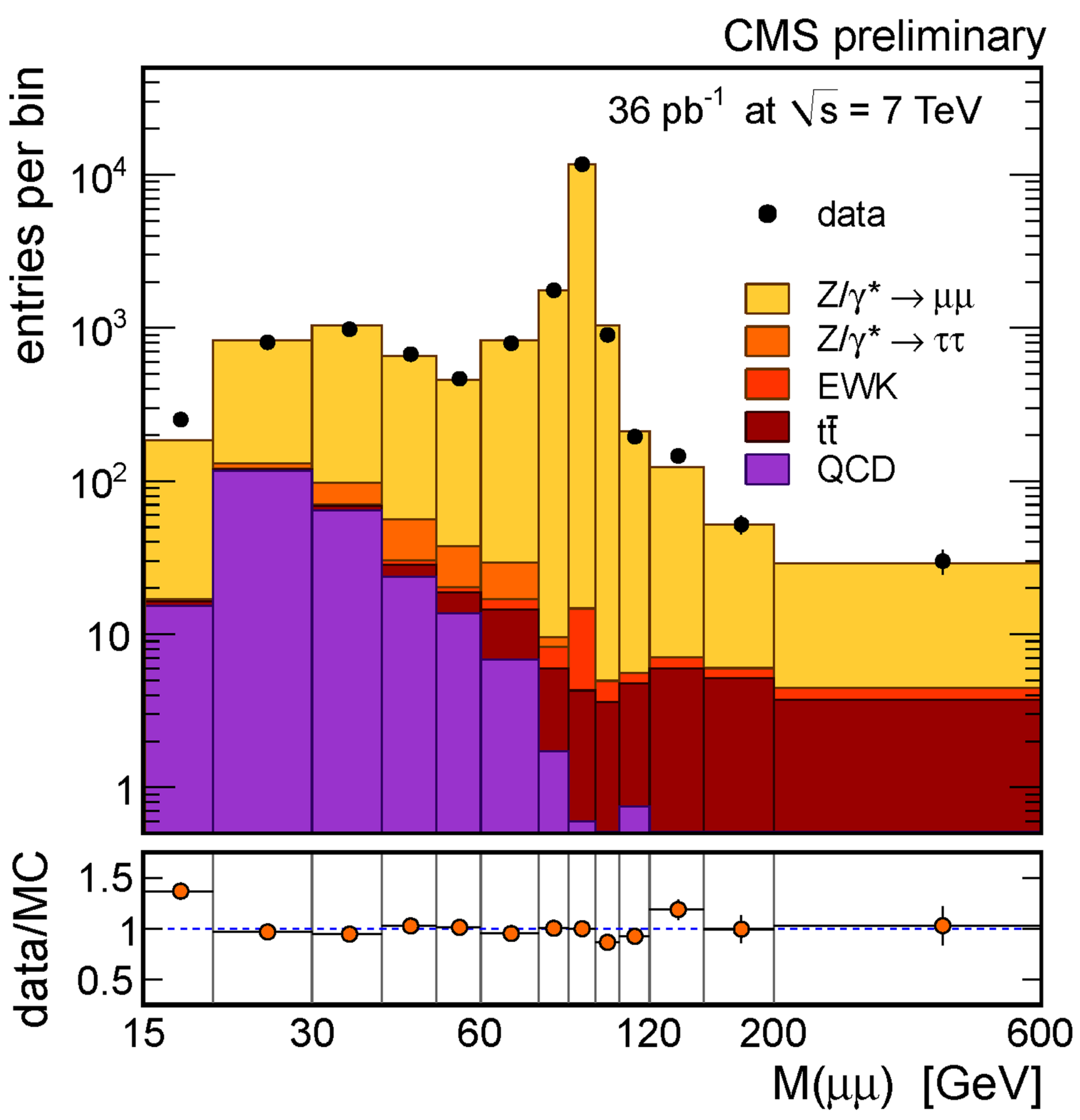


The normalized Drell-Yan mass spectrum is found in the di-muon channel and compared to theoretical predictions. Model uncertainties account for differences in the acceptance corrections obtained with POWHEG (NLO) and FEWZ (NNLO).

Analysis

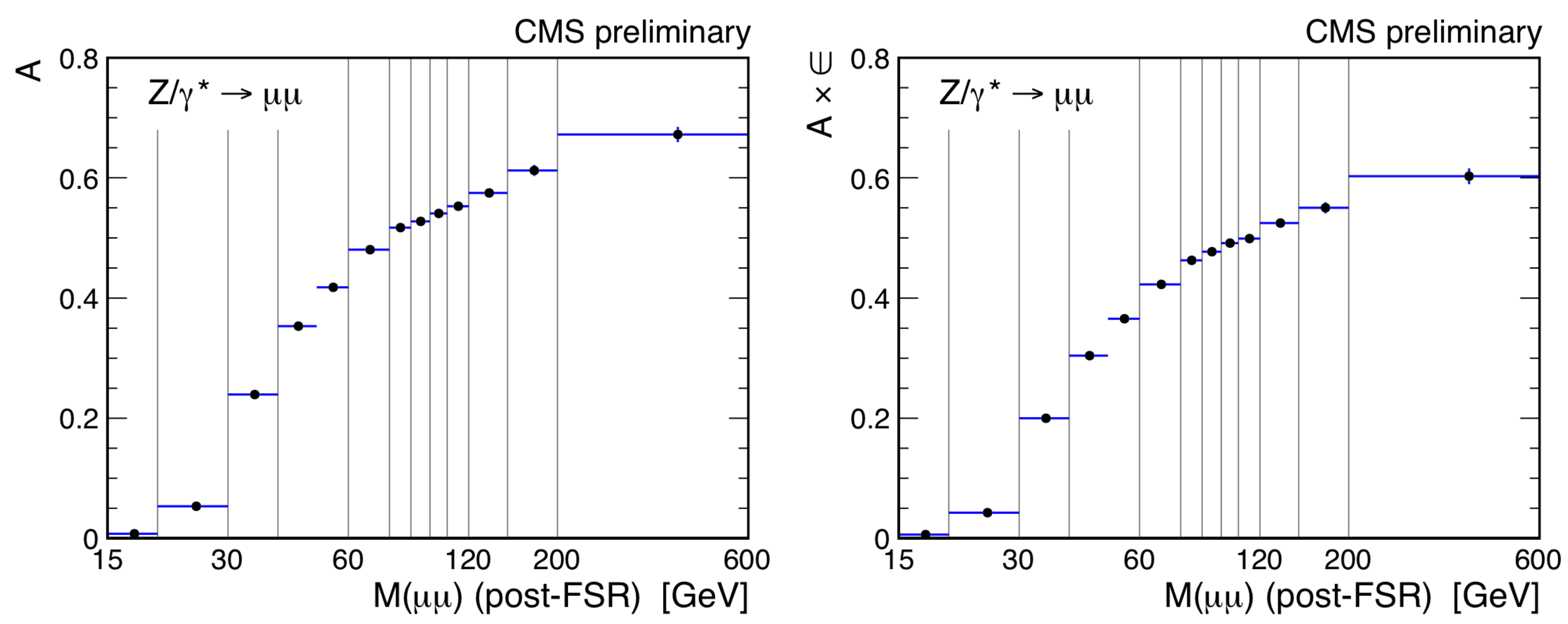
We start with the raw invariant mass spectrum. At low mass regions, QCD multi-jets form the dominant background; at intermediate masses below the Z pole, $Z \rightarrow \tau^+\tau^-$ dominates; at high masses, $t\bar{t}$ and di-boson production are the dominant backgrounds.

Muons are selected such that one muon must have $p_T > 7$ GeV/c and $|\eta| < 2.4$, while the other muon must have $p_T > 16$ GeV/c, $|\eta| < 2.1$ and must be matched to a muon trigger object. Di-muon Drell-Yan candidates must be isolated, of opposite charge and share a common vertex.



Acceptance and Efficiency Corrections

After unfolding, we apply mass-dependent corrections for acceptance and efficiency. Acceptance is defined as the fraction of events that pass p_T and η requirements. Efficiency accounts for reconstruction and identification losses. Acceptance corrections are model dependent and are accounted for in the systematic uncertainty.



DY acceptance per mass bin.

DY acceptance times efficiency per mass bin