Muon Charge Asymmetry in Inclusive $pp \to W(\mu\nu) + X$ production at $\sqrt{s} = 7$ TeV.

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Outline

- Physics motivation of measuring the muon charge asymmetry.
- The recorded luminosity profile.
- Overview of muon reconstruction with the CMS detector.
- The key kinematic variables to select the muon events coming from W.
- Results of the muon charge asymmetry and associated systematics.
- Conclusion.

Parton-level cross section

$$d\sigma_X = \sum_{ij} \int dx_1 dx_2 f_i(x_1, Q^2) f_j(x_2, Q^2) d\hat{\sigma}_{ij \to X}$$

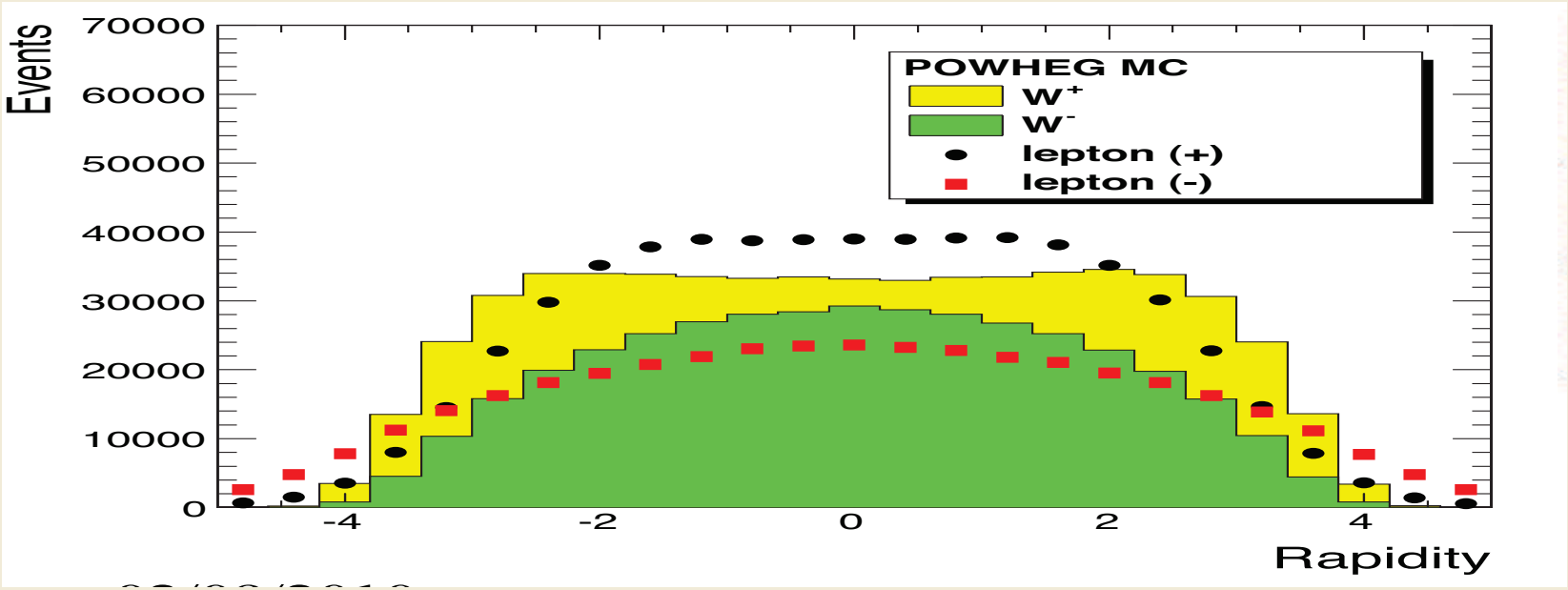
- We will measure the charge asymmetry defined by :
  $A(\eta) = \frac{\frac{d\sigma}{d\eta}(W^+ \to \mu^+ \nu_\mu) - \frac{d\sigma}{d\eta}(W^- \to \mu^- \nu_\mu)}{\frac{d\sigma}{d\eta}(W^+ \to \mu^+ \nu_\mu) + \frac{d\sigma}{d\eta}(W^- \to \mu^- \nu_\mu)}$
- Taking the ratio, we can get rid of many experimental systematics.
- If we can handle our systematics properly, then this measurement can constrain the Parton Distribution Function.

The production and decay of the W-events

Generator level information

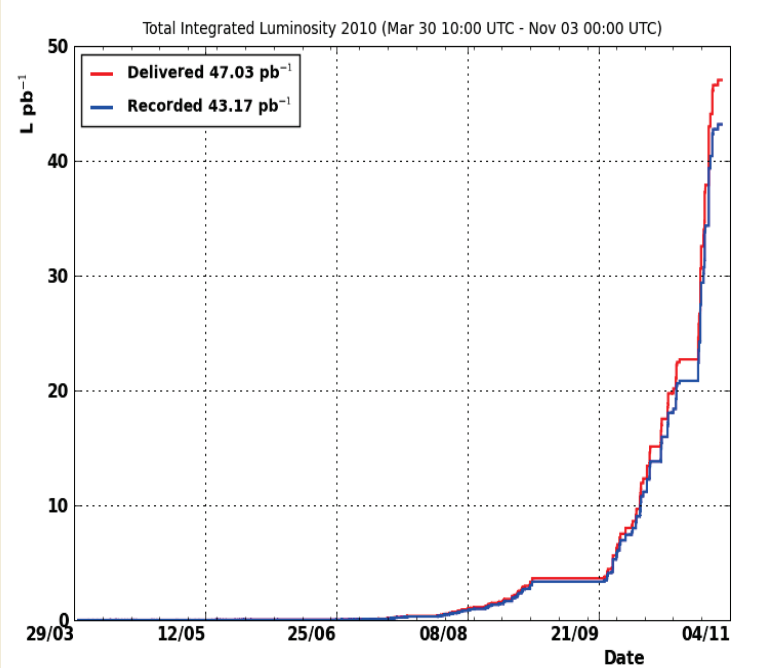
- The W^+ and consequently the μ^+ events are produced more than the W^- and μ^-.
- The following figure shows the pseudorapidity dependence of the W and muon events for both the charges from POWHEG Monte-Carlo.

Production of W-events



Total luminosity recorded by CMS

Luminosity profile

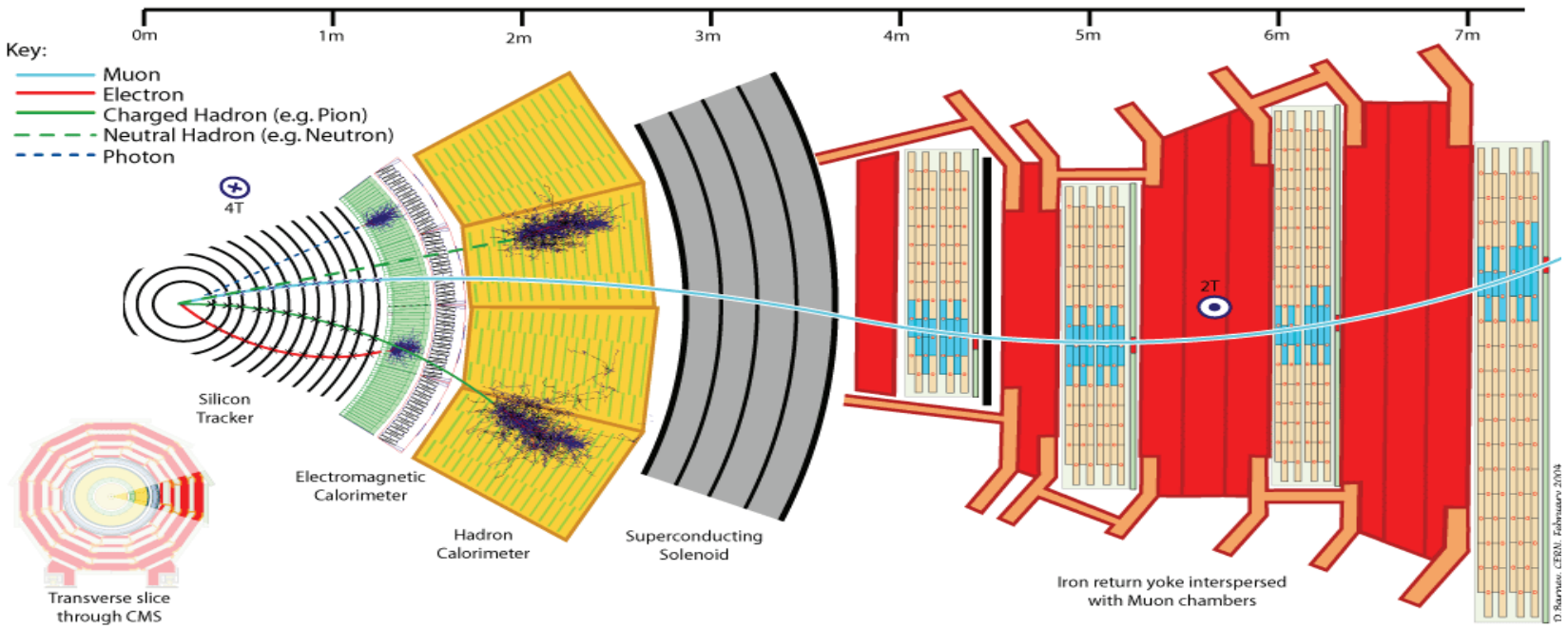


Disclaimer

- Although CMS has recorded around 43 pb^{-1} of data, out of them 38 pb^{-1} is certified, we will show the results from the data set 198 nb^{-1}, when the results were last approved by CMS collaboration.

Muon reconstruction in CMS

- Muons are reconstructed with its hits in tracker and the muon chambers.
- We put some criteria related to the tracker and muon chambers to select the "good" muons.



The $W \to \mu\nu$ baseline selection criteria

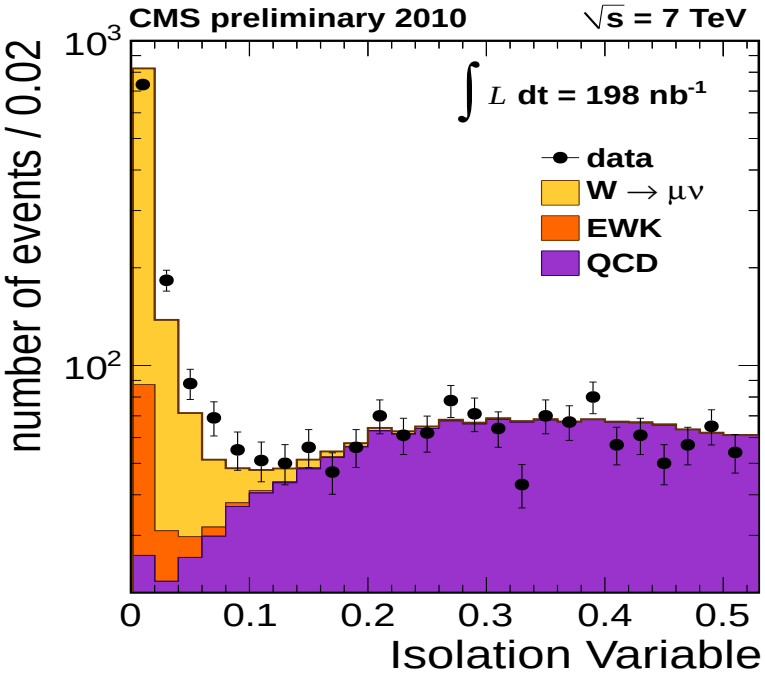
- Muon-Id criteria:
  - Muon is identified as both global muon and tracker muon.
  - Number of hits in the tracker > 10, number of pixel hits > 0, number of matches in muon chamber > 2 and $\chi 2/ndf < 10$.
  - Transverse impact parameter of the muon with respect to the beam spot < 2 mm and $|\eta^{\mu}| < 2.1$.
- Trigger Criteria:

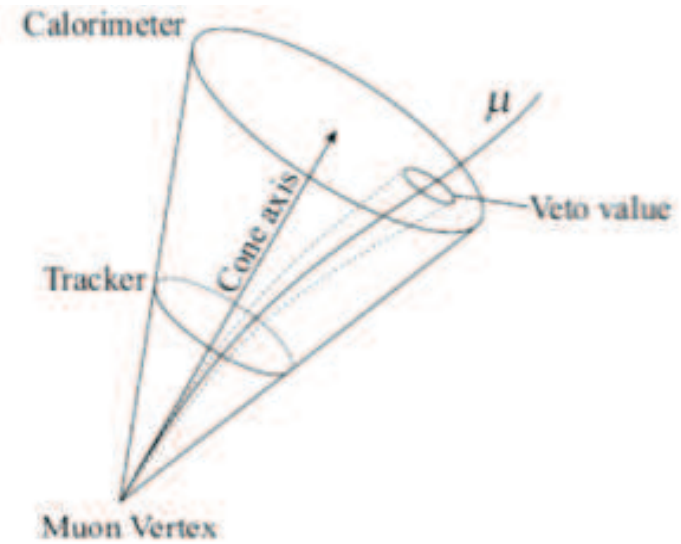
  Muon matched with HLT_Mu9 trigger criteria.
- Specific selection criteria to select $W \to \mu\nu$ events:
  - Muon Pt > 20 GeV.
  - Relative combined isolation = (sumPt + emEt + hcalEt)/ptmu < 0.15 in a $\delta R < 0.3$ cone.
- Muon-veto criteria:

  Reject the event if there is any second muon with transverse momentum > 10 GeV.

Isolation

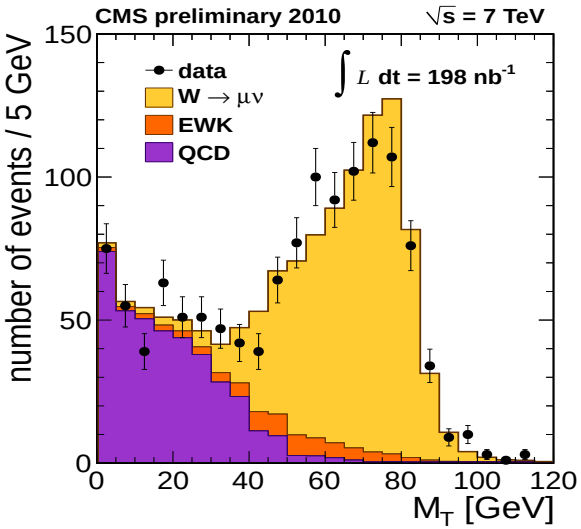
- $I^{rel}_{comb} = \sum_{R(caloTower^i, muon)<0.3}(E_T^{ECAL^i} + E_T^{HCAL^i} + P_T^{\mu^i})/P_T^{\mu}$, where the sum of the transverse energies of ECAL, HCAL towers and tracker transverse momentum in the tracker within a cone of radius 0.3 around the muon direction.
- The muon is defined to be isolated $I^{rel}_{comb} < 0.15$.

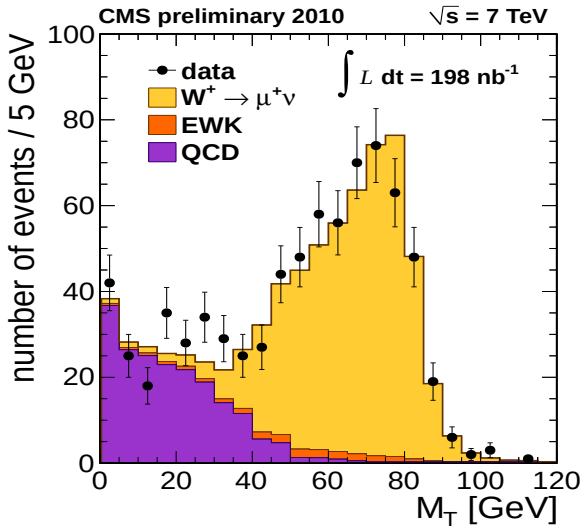


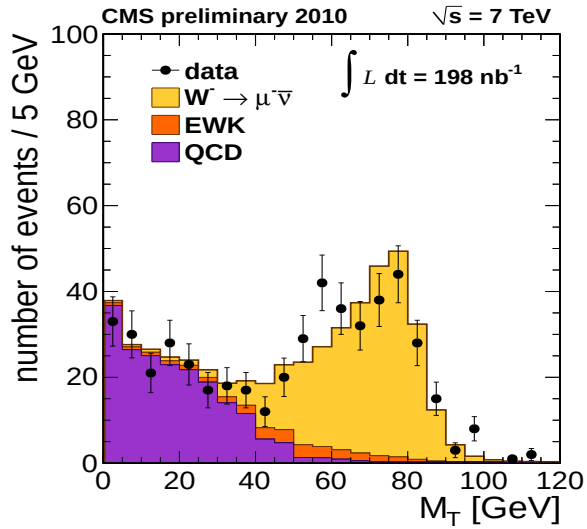


W transverse mass

- After putting the good muon selection and isolation criteria we estimate the signal and background by fitting M_T spectrum.
- $M_T = \sqrt{2 \cdot P_T^{\mu} \cdot \not{E}_T \cdot (1 - cos(\phi))}$, ϕ is the angle between muon P_T^{μ} and $\not{E}_T$.
- The $\not{E}_T$ is the missing energy measured in the detector, the main source of it is the neutrino, which are not detected in the detector.

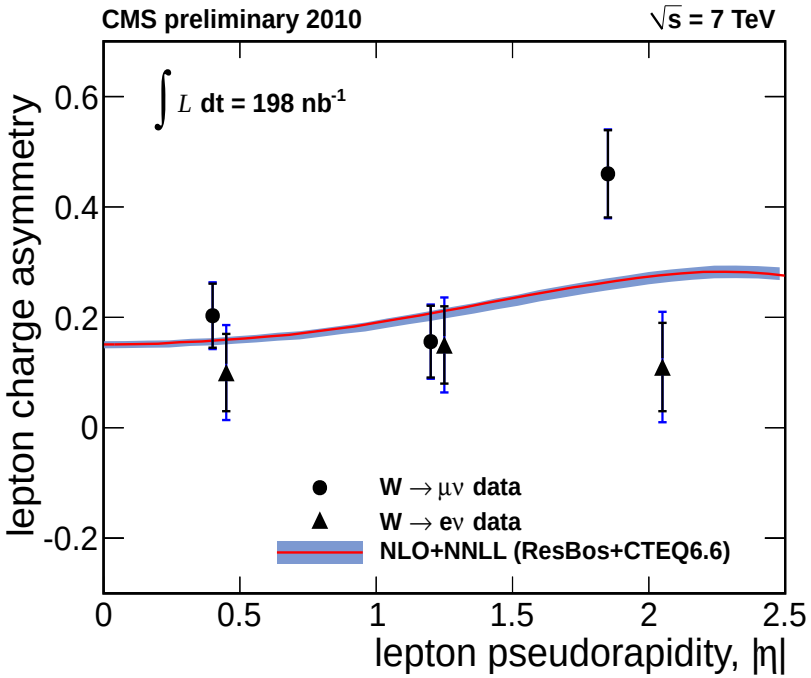






Results of charge asymmetry

- $A(\eta) = \frac{\frac{d\sigma}{d\eta}(W^+ \to \mu^+ \bar{\nu_\mu}) - \frac{d\sigma}{d\eta}(W^- \to \mu^- \nu_\mu)}{\frac{d\sigma}{d\eta}(W^+ \to \mu^+ \bar{\nu_\mu}) + \frac{d\sigma}{d\eta}(W^- \to \mu^- \nu_\mu)}$
- The variation of asymmetry as a function of pseudorapidity is measured.
- Due to less statistics we have only three bins, but for larger statistics this measurement can be done in more than three bins.



Systematic uncertainties for estimating background yields

- The luminosity uncertainty is 11 %, although this uncertainty does not affect us, as we are measuring the charge asymmetry (the ratio).
- Muon reconstruction and identification efficiency is 5 %.
- Muon isolation efficiency 0.5 %.
- Muon trigger scale factor of 0.9 with an uncertainty of 2 %.
- Theoretical uncertainty of $t\bar{t}$, Drell-Yan production cross-sections 5 %.
- The difference in these uncertainties are calculated separately for positive and negative muons to correctly measure the charge asymmetry.

Conclusion

- With larger statistics we can improve our systematics.
- The analysis with the full data is going on.