W Cross-section ratio pp500 run 12

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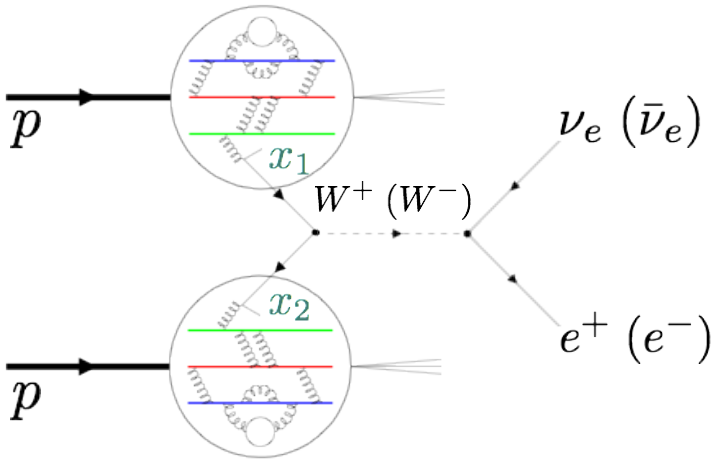
Outlook

- Measurement of W cross-section ratio : Motivation
- First raw results on Run 2012
  - Track selection
  - Cluster selection
  - W+/- uncorrected cross-section
- First look on W- embedded data
- Summary

Theoretical foundation

- STAR W program in $e^{+/-}$ decay mode at mid-rapidity and forward/backward rapidity



$$y_l = y_W + \underbrace{\frac{1}{2}\ln\frac{1+\cos\theta^*}{1-\cos\theta^*}}_{y_l^*}$$

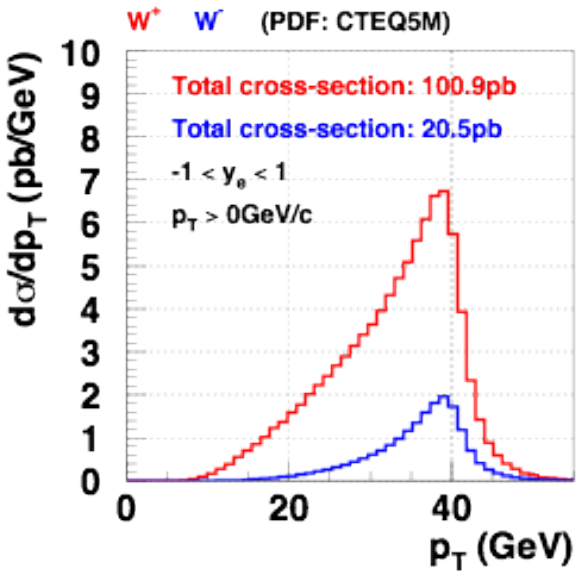
$$p_T = p_T^* = \frac{M_W}{2}\sin\theta^*$$

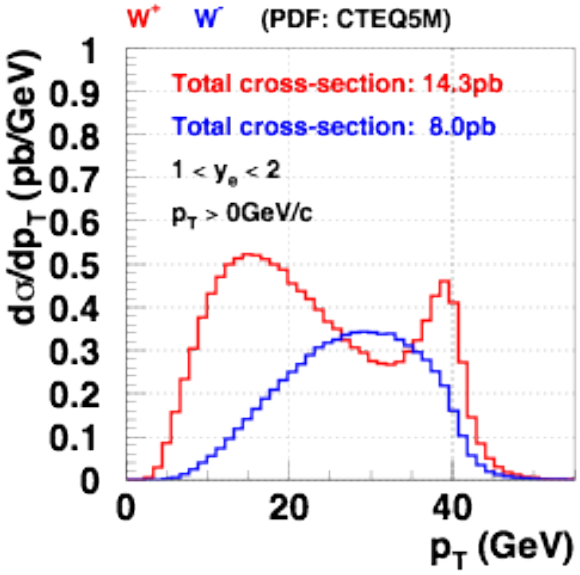
$$x_1 = \frac{M_W}{\sqrt{s}}e^{y_W}$$

$$x_2 = \frac{M_W}{\sqrt{s}}e^{-y_W}$$

$$\frac{M_W}{\sqrt{s}} = 0.16$$

- Key signature: High p_T lepton (e^-/e^+)(Max. $M_W/2$) - Selection of W^+/W^- : Charge sign discrimination of high p_T lepton
- Required: Lepton/Hadron discrimination

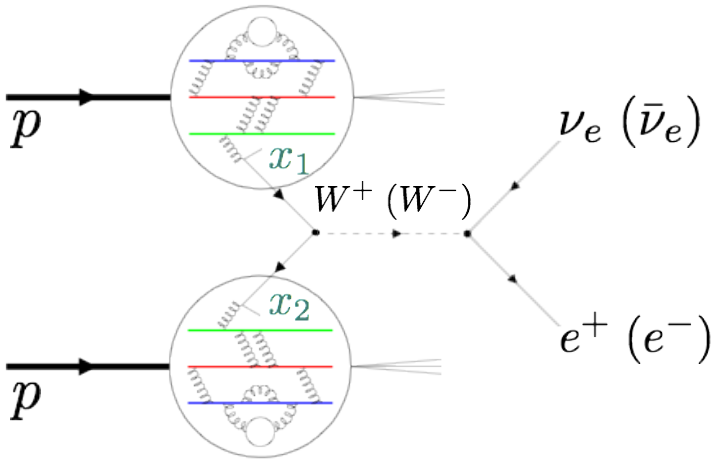




Total (√s=500GeV) σ(W^+)=135pb and σ(W^-)=42pb

Theoretical foundation

- STAR W program in $e^{+/-}$ decay mode at mid-rapidity and forward/backward rapidity



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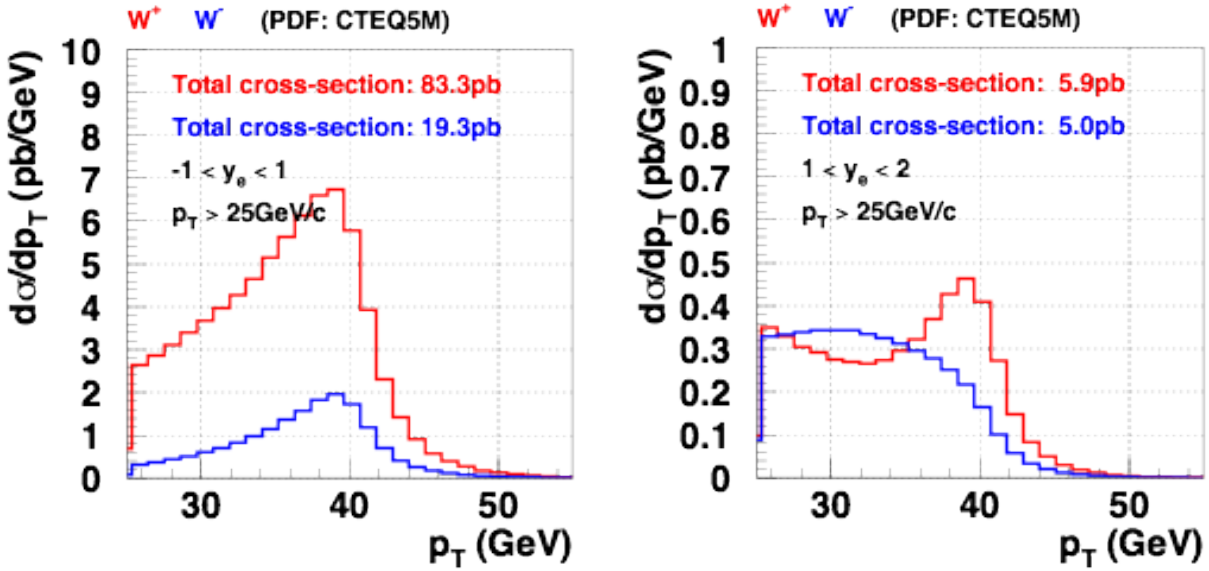
Cut on p_T :



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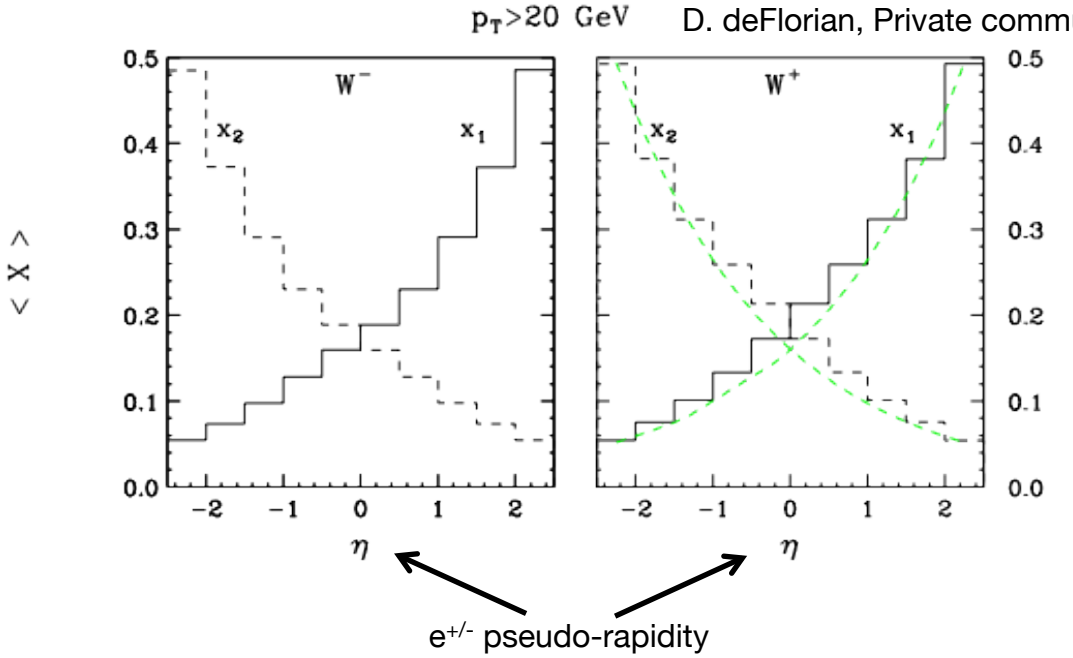
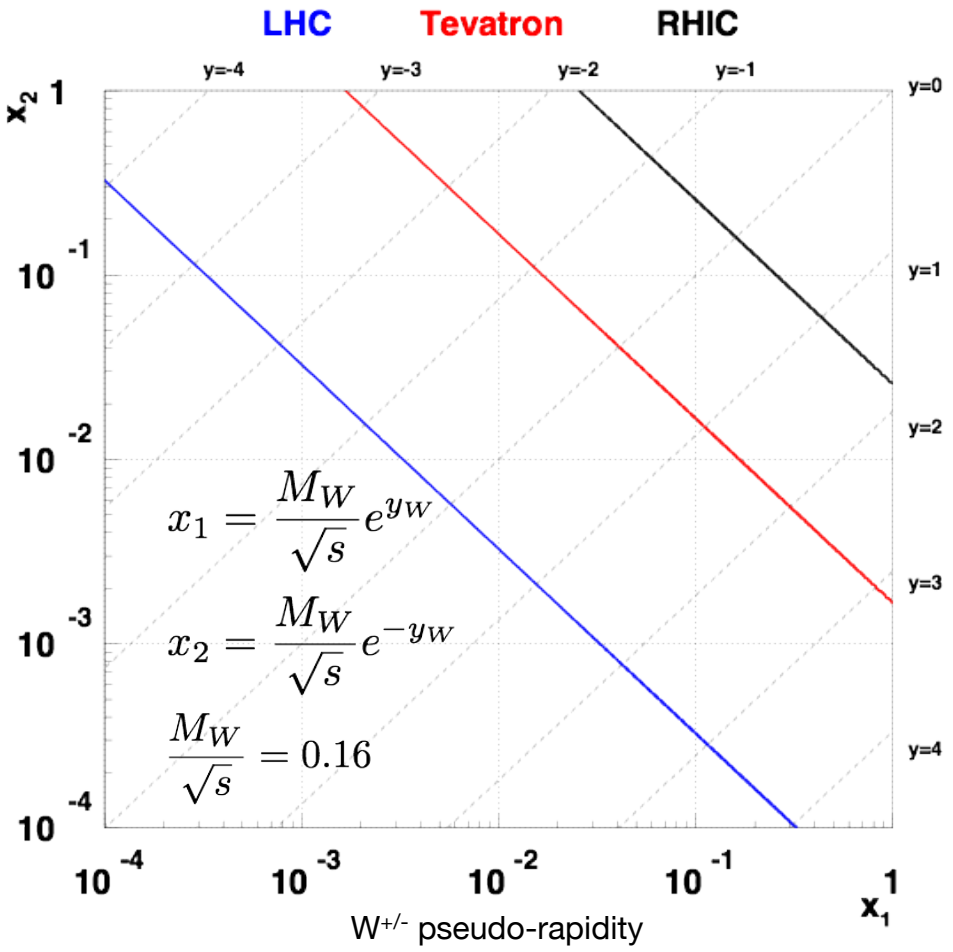
Theoretical foundation

- Kinematic range of W production at RHIC





- Approximate kinematic range at RHIC: 0.06 < x < 0.4 for -2 < η < 2
- Measurement at LHC in high-x range would require very forward measurements

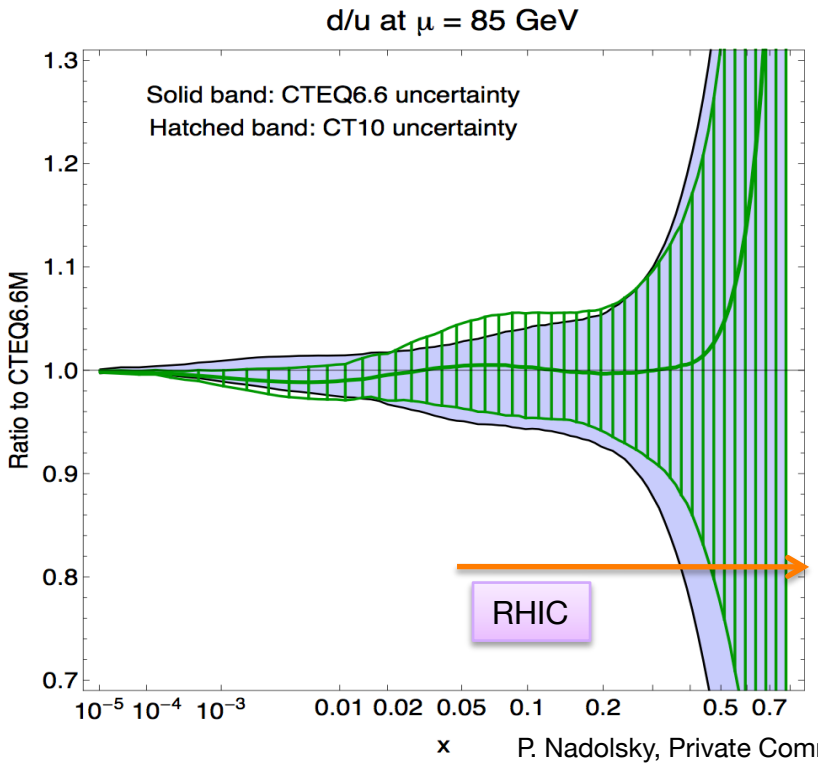
Theoretical foundation

- Large-x uncertainties of unpolarized distribution functions

Agreement of PQCD with D0 $A_e(y_e)$	Order of α_s	χ^2/npt	Source
CTEQ6.6	NLO	191/36=5.5	*Our study*
CT10W	NLO	78/36=2.2	
ABKM'09	NNLO	540/24=22.5	*Catani, Ferrera, Grazzini, JHEP 05, 006 (2010)*
MSTW'08	NNLO	205/24=8.6	
JR09VF	NNLO	113/24=4.7	

P. Nadolsky, Private Communications.

- Important constrain from lepton asymmetry on d/u at high-x
- Puzzle: NLO calculations based on recent PDFs fail to describe most precise charged-lepton asymmetry $A_e(y_e)$ measurements
- Potential input from RHIC focusing on high-x and high-Q^2 measurements

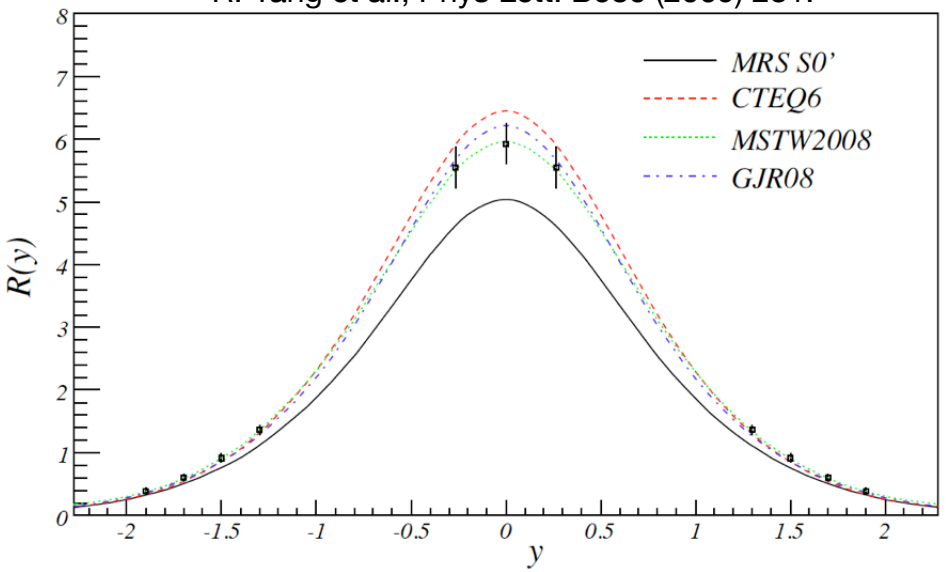


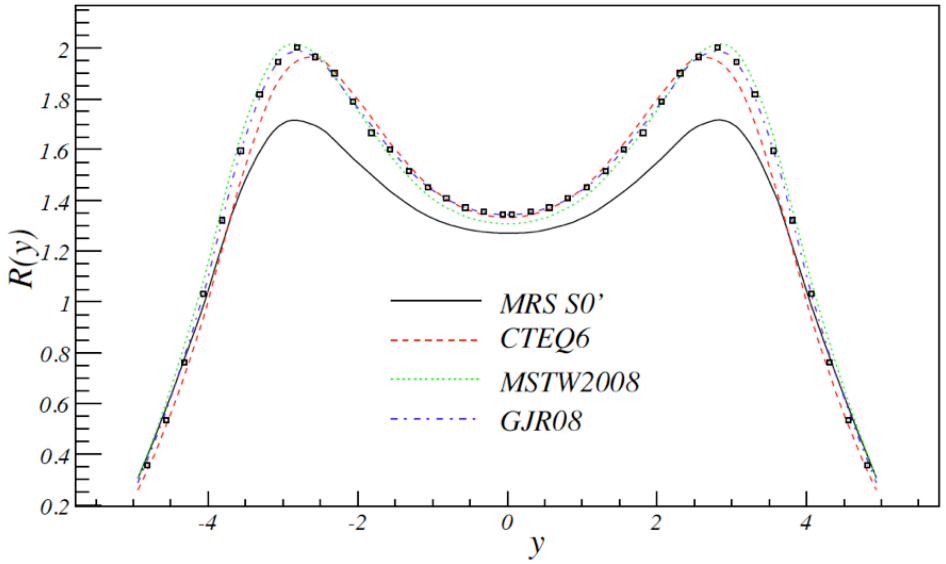
P. Nadolsky, Private Communications.

Theoretical foundation

- Cross-section ratio R_W

R. Yang et al., Phys Lett. B680 (2009) 231.





- RHIC provides solid sensitivity to unpolarized distribution functions, in particular at mid-rapidity constraining dbar / ubar at high-x and high-Q^2

$$R(x_F) \equiv \frac{\sigma_{W^+}}{\sigma_{W^-}} = \frac{u(x_1)\bar{d}(x_2) + \bar{d}(x_1)u(x_2)}{\bar{u}(x_1)d(x_2) + d(x_1)\bar{u}(x_2)}$$

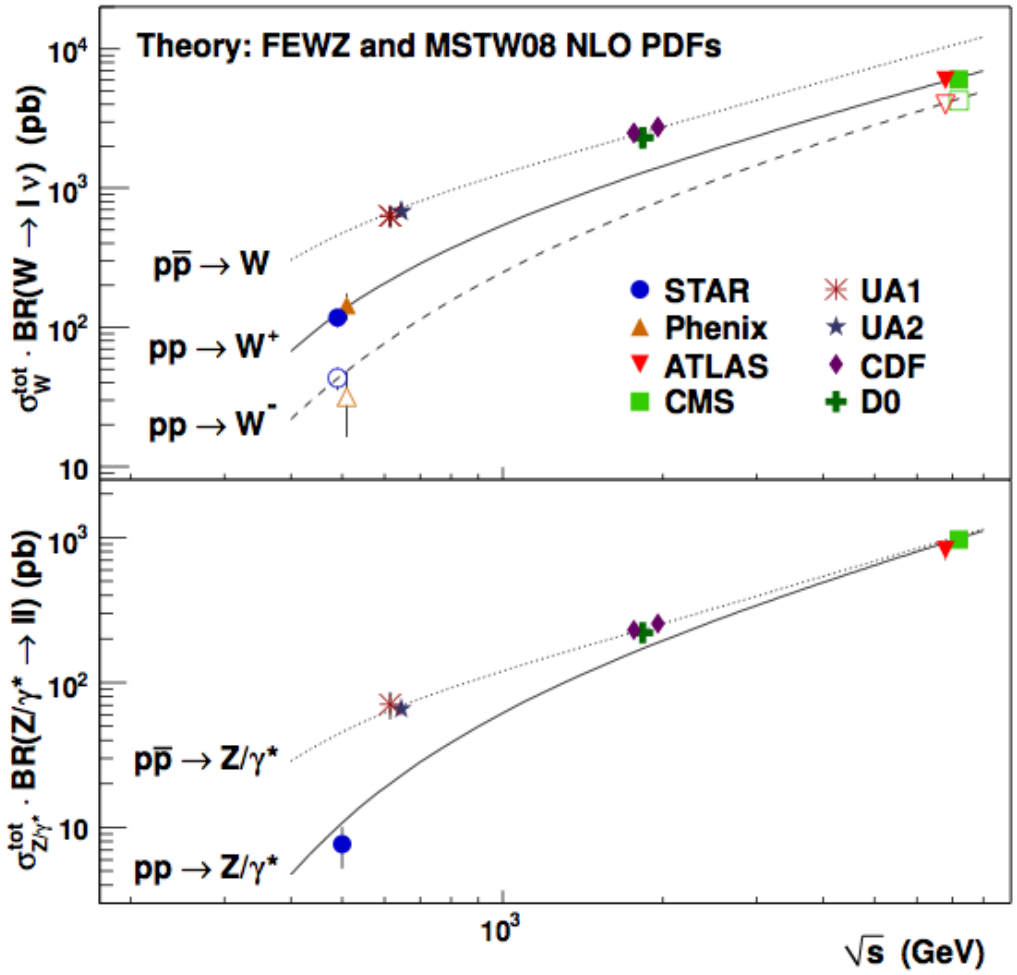
LO decomposition of cross-section ratio $R(x_F)$

- RHIC projections (PHENIX): 300pb^{-1} at $\sqrt{s}$=500GeV
- LHC projections: 10fb^{-1} at $\sqrt{s}$=14000GeV

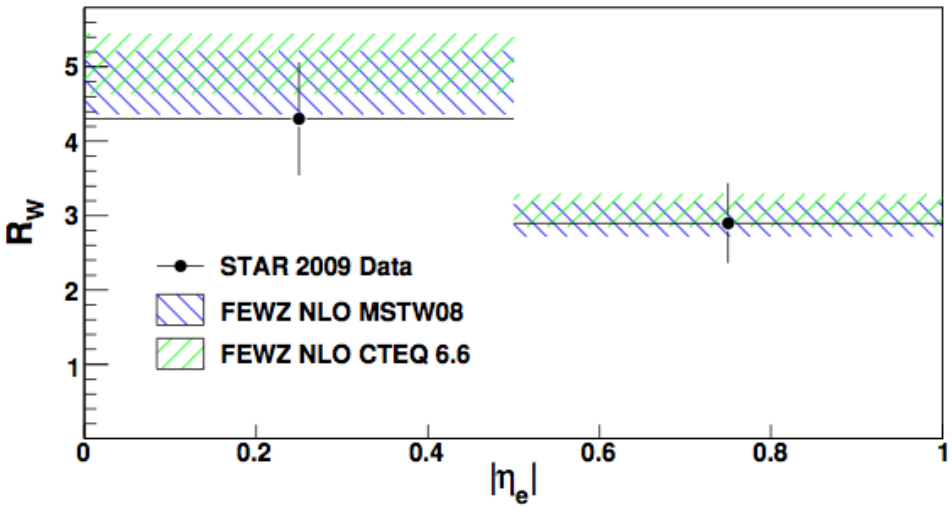
Recent results - W/Z production

- STAR $W^{+/-}$ and Z / γ* cross-section results

Absolute cross-sections



Run 2009 - Cross-section ratio



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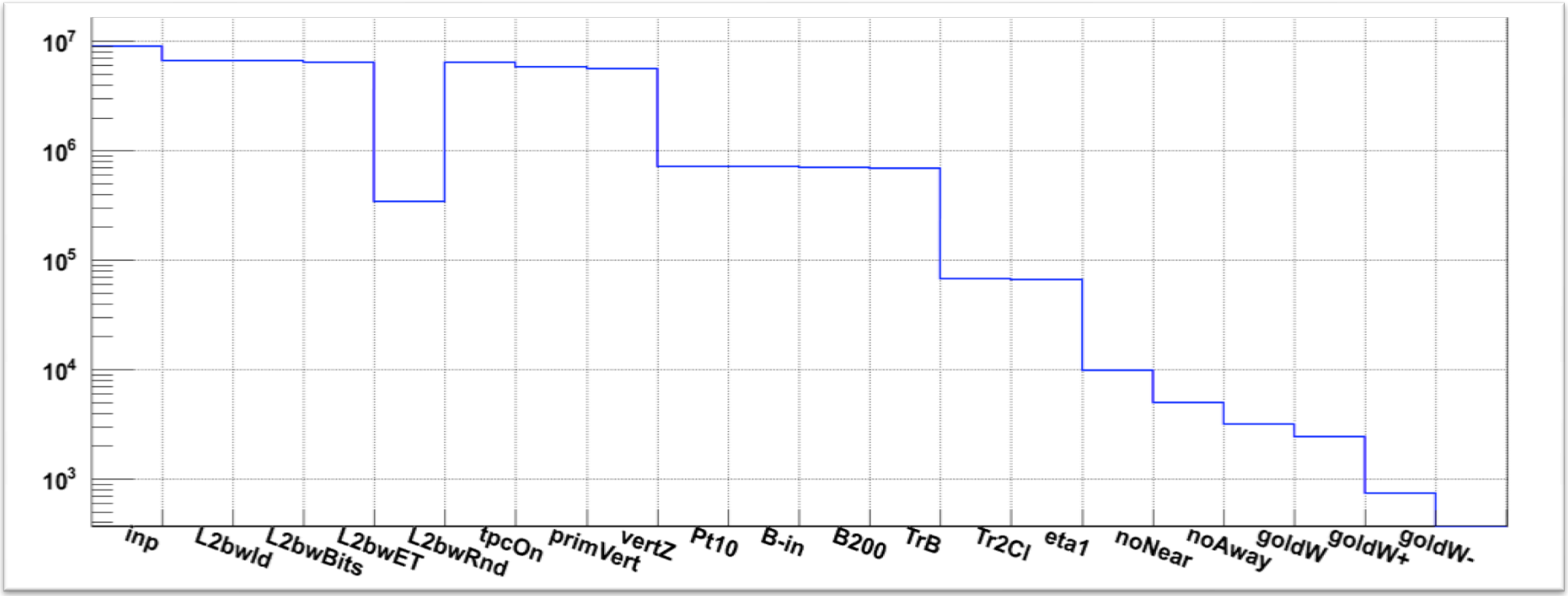
LO decomposition of cross-section ratio $R(x_F)$

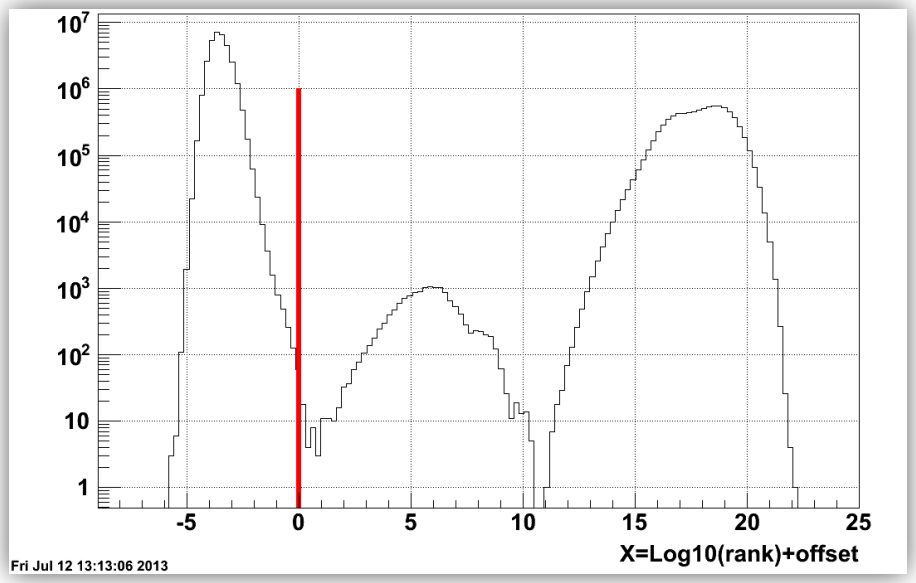
Run 2012 - W data set

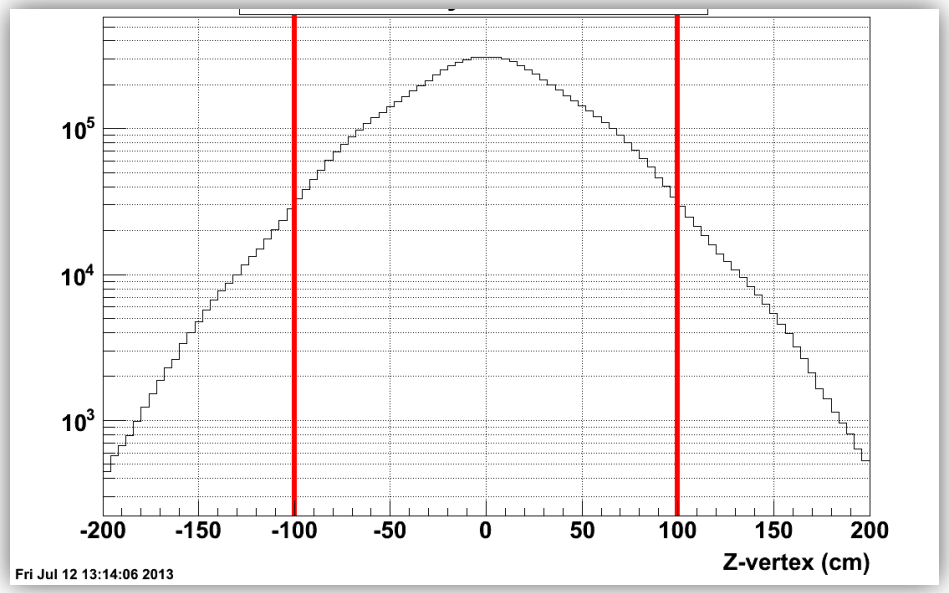
- Run 2012 decoded statistics :
  - p13ib 685 runs ~10^7 events => 4934 W, 3167 Golden W (>25GeV)
    - Previous production 8.6x10^6 events => 985 Golden W

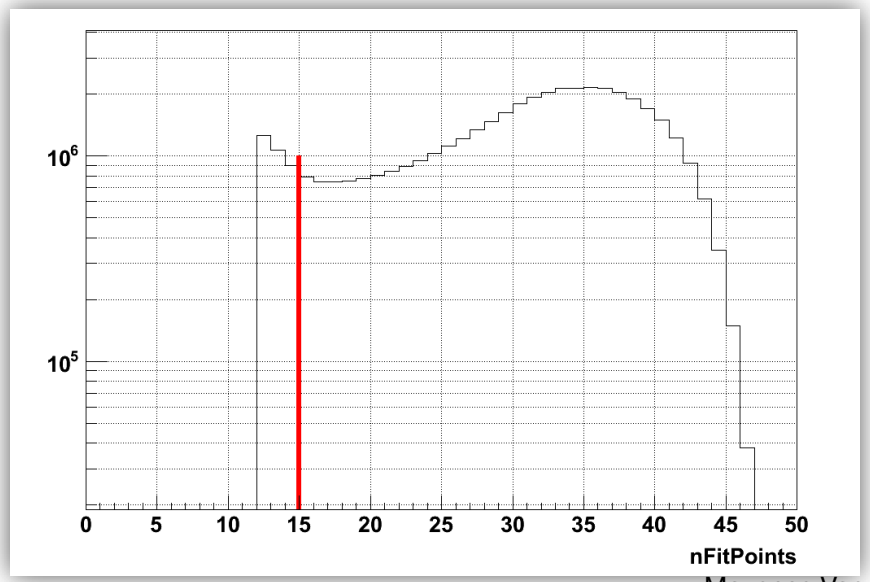


W reconstruction

- Track Selection (1)
  - Vertex rank > 0
  - |Z vertex| < 100 cm
  - N Fitted Points > 15

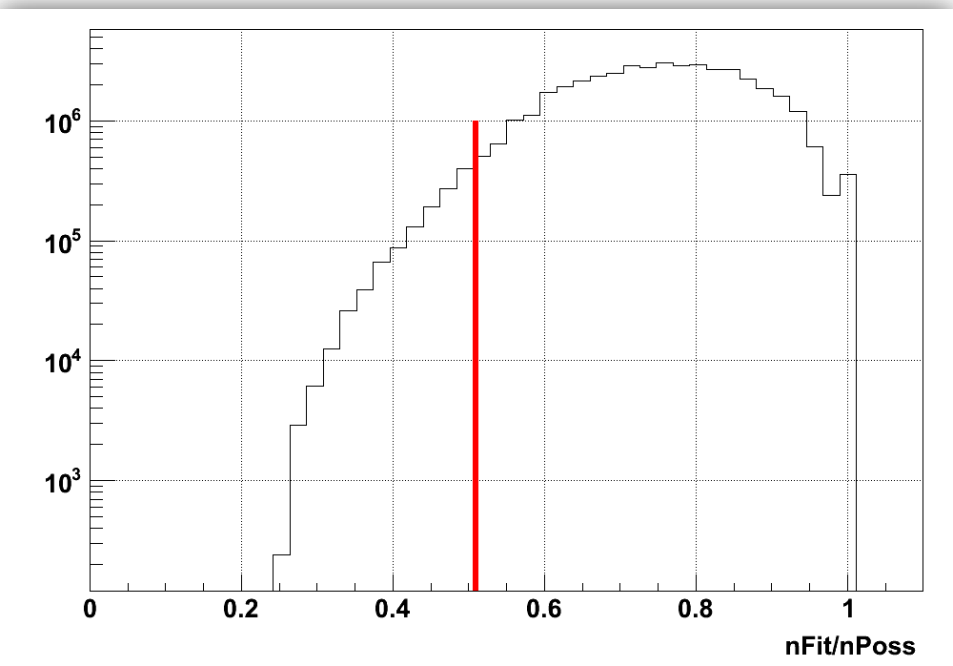


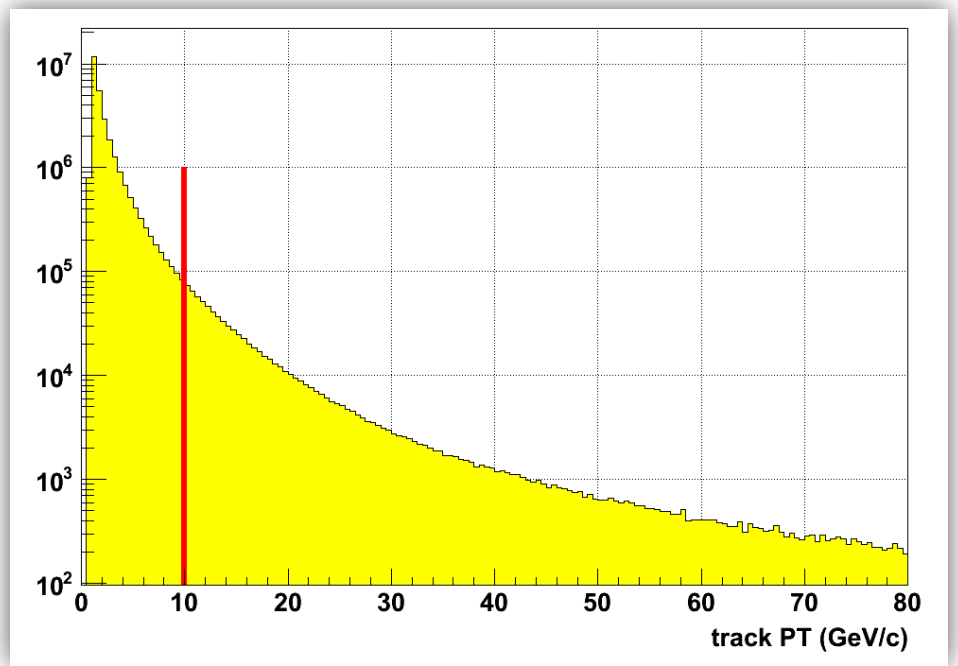




W reconstruction

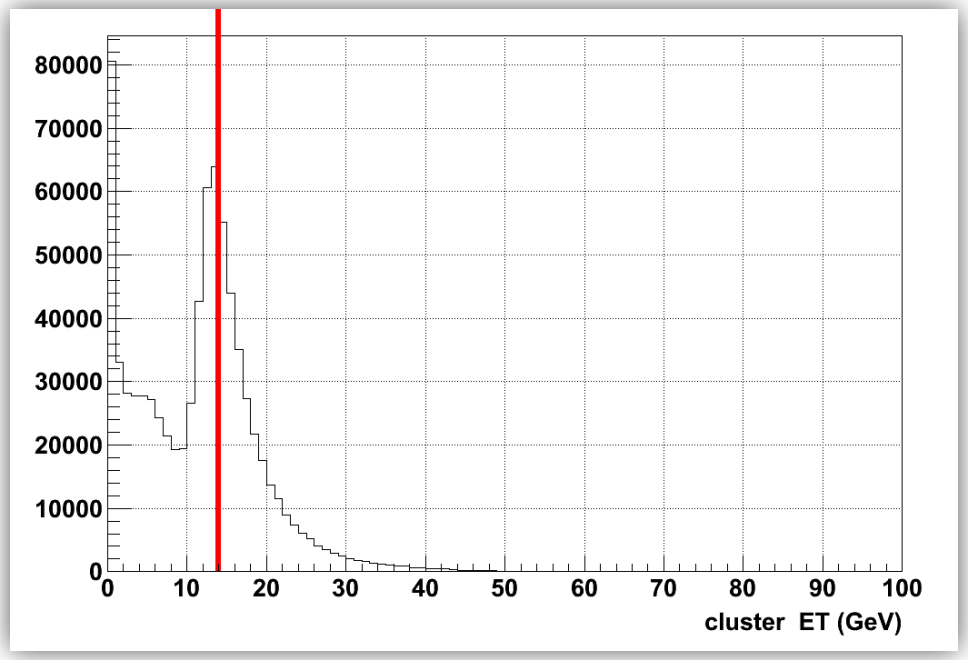
- Track Selection (2)
  - $N_{Fit}/N_{possible} > 0.51$
  - Track $P_T > 10$ GeV/c

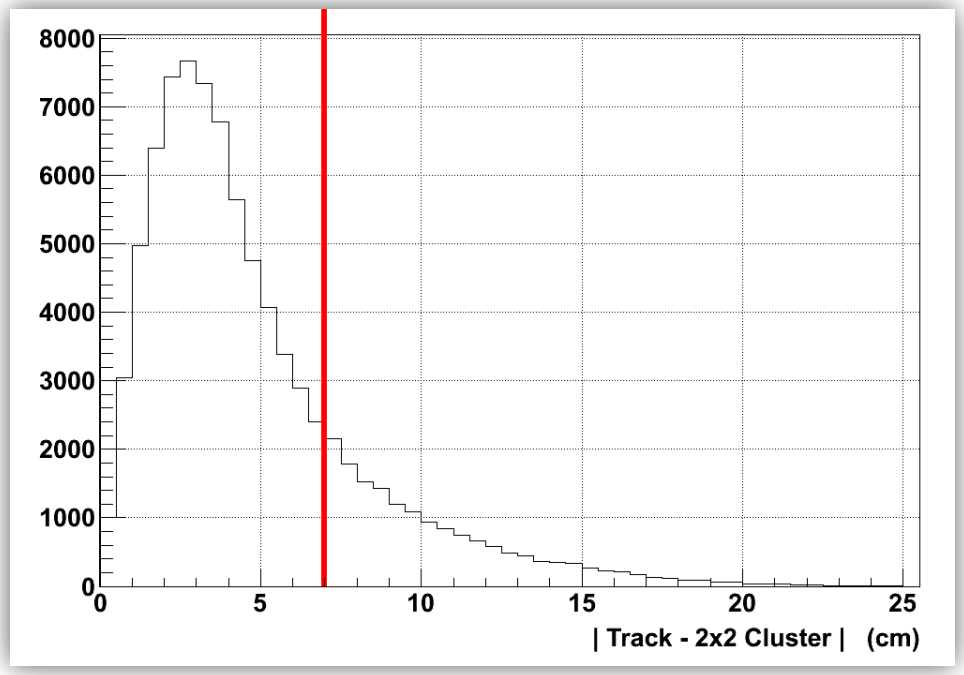




W reconstruction

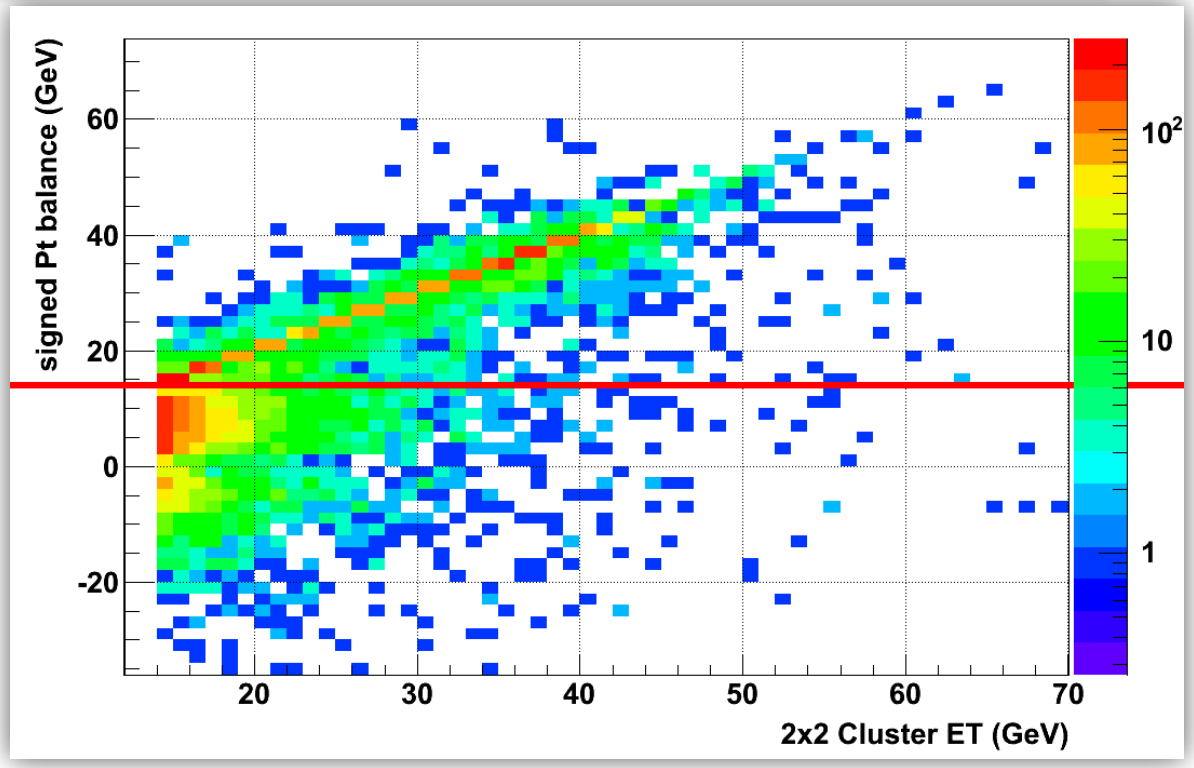
- Cluster Selection
  - $E_T > 15$ GeV
  - Track – Cluster < 7 cm

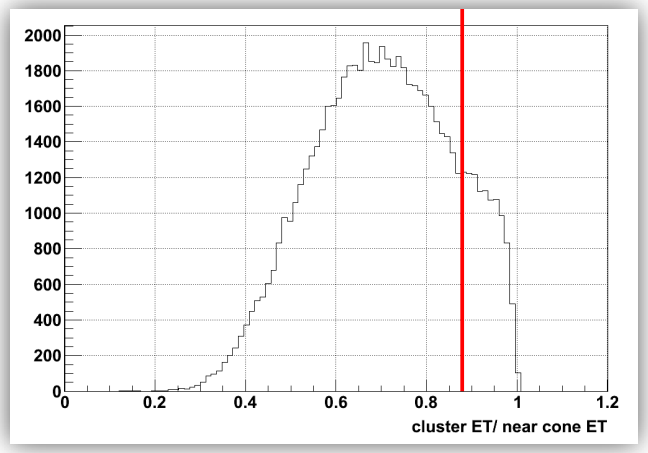


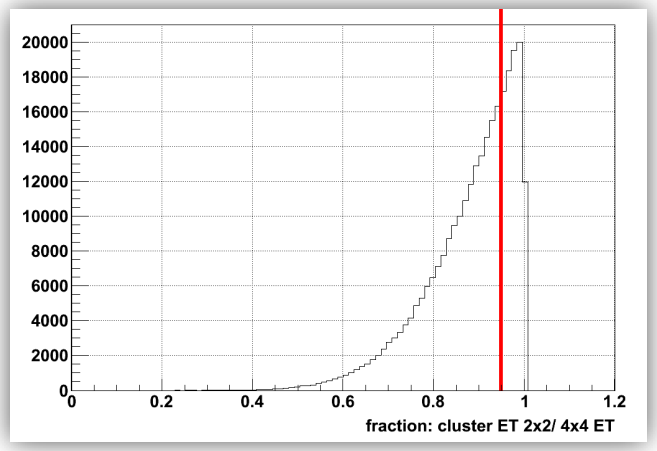


W reconstruction

- Isolation cut
  - 2x2/4x4 > 0.95
  - E_T / (near cone) < 0.88
  - Signed P_T balance > 15 GeV

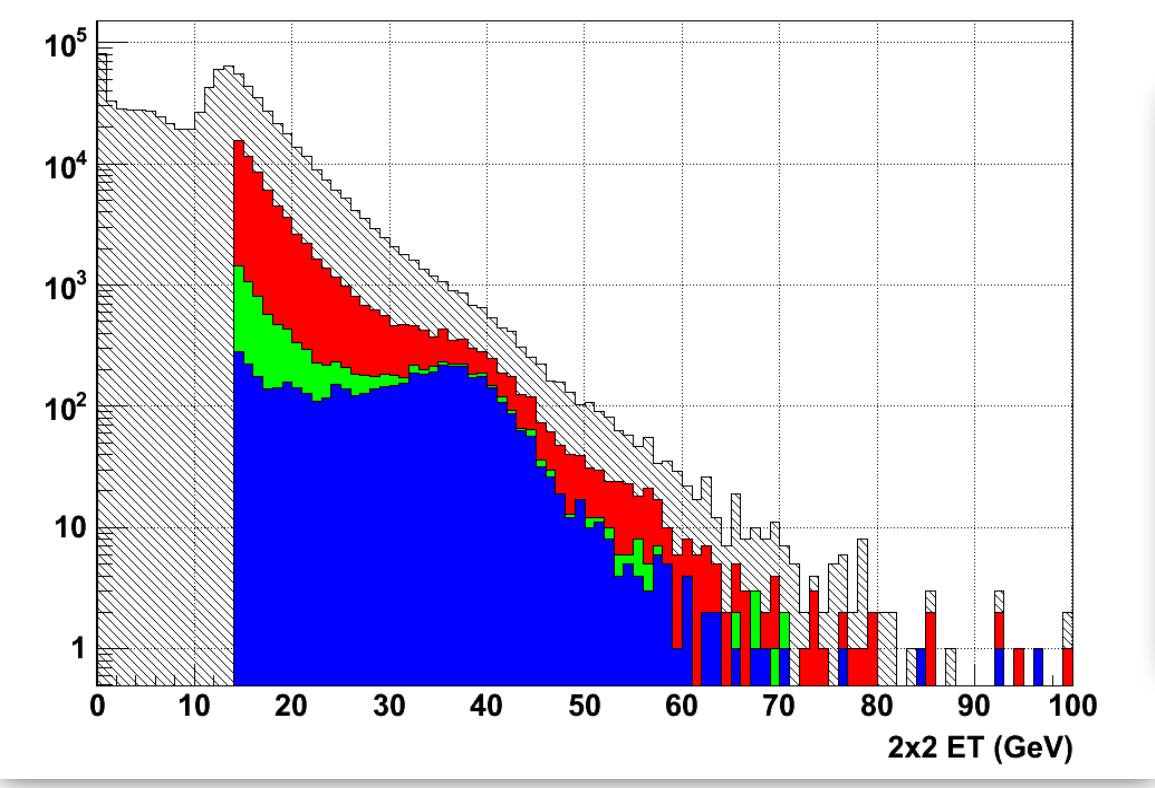


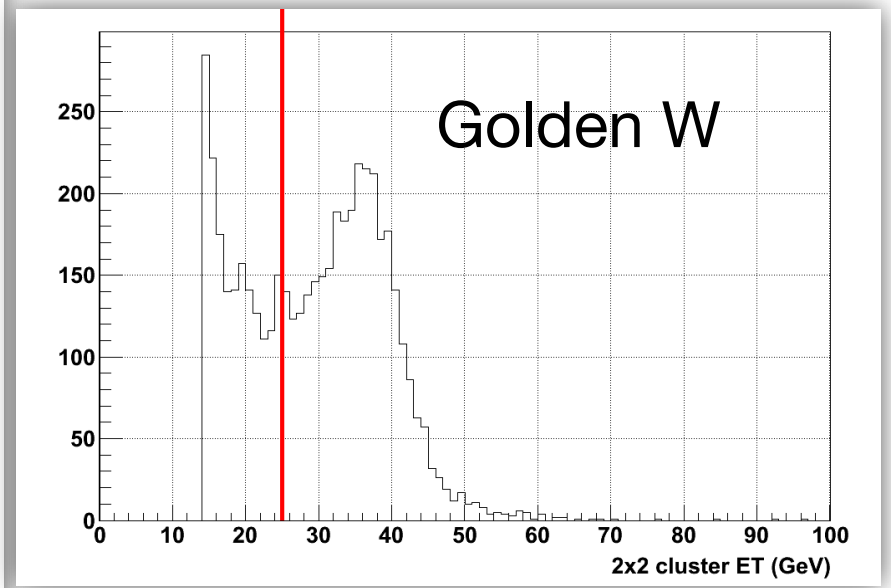




W selection

- W Background reduction graph
  - Black // : Barrel electron candidate, cut=max 2x2
  - Red : Barrel electron candidate, cut=track matched
  - Green : Barrel electron candidate, cut=no near ET
  - Blue : Barrel electron candidate, cut=no away ET

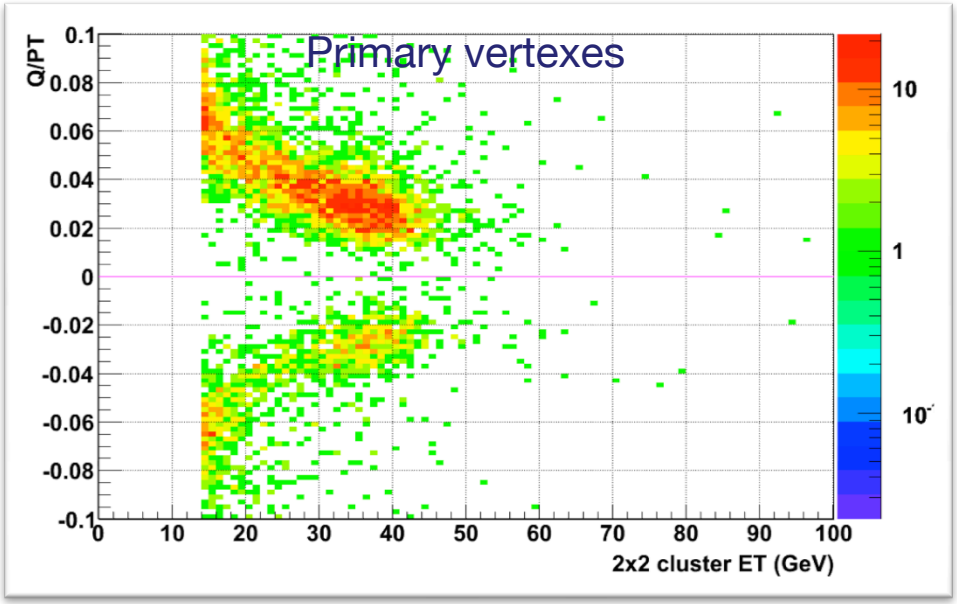


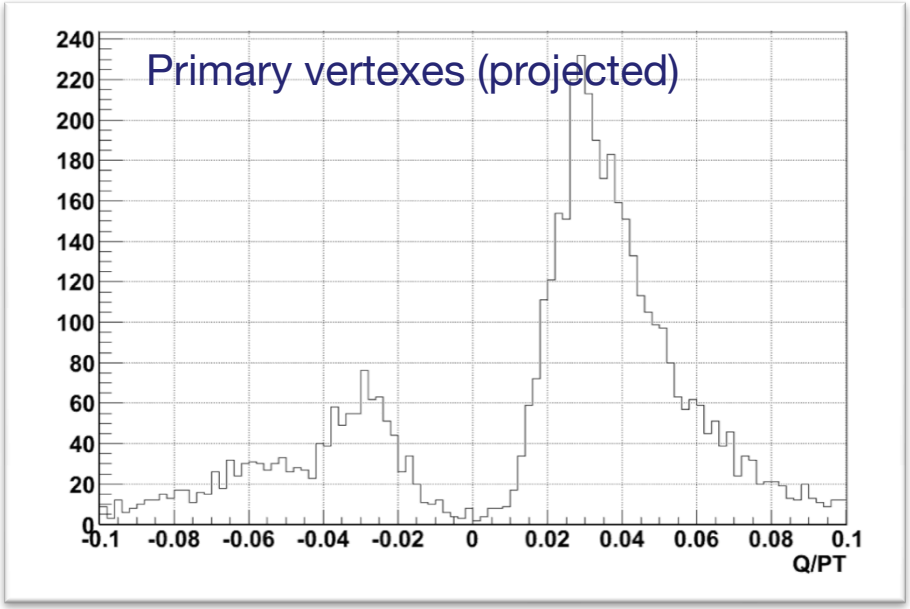


4934 W, 3167 Golden W

Charge reconstruction

- Charge Separation of leptons

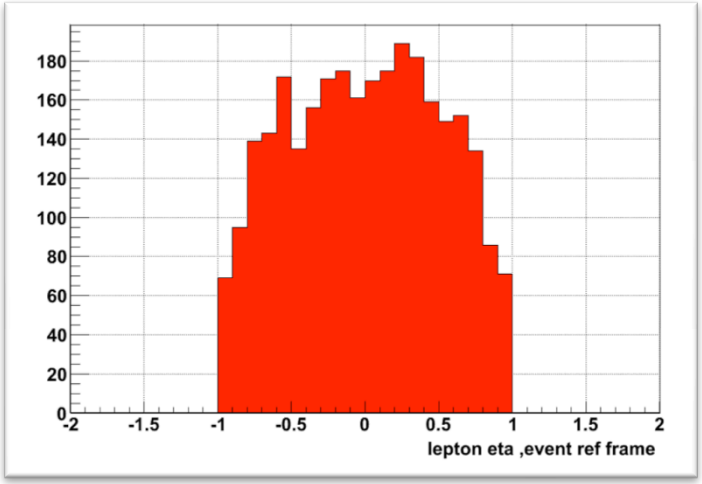


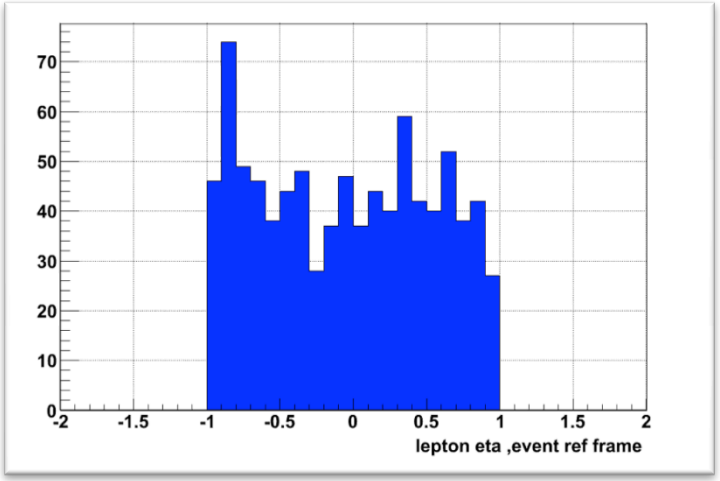


=> Separation yields to be calculated

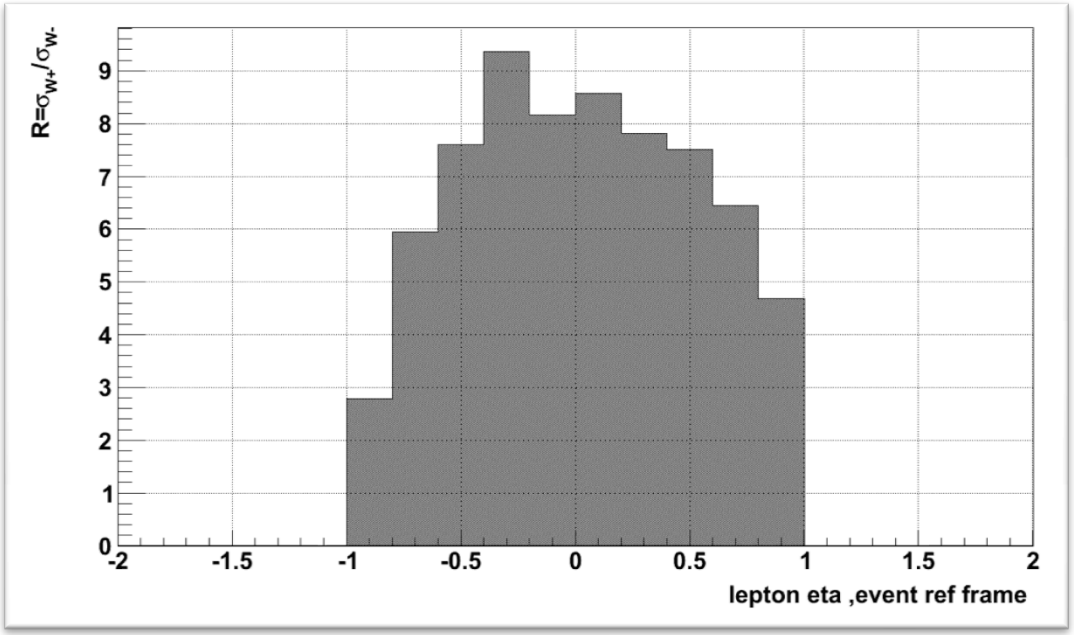
W raw cross-sections results

- W+ and W- Cross-sections
  - Raw W+ prod.
  - Raw W- prod.





- Raw Ratio
  Uncorrected



=> Next steps: Efficiency and background corrections

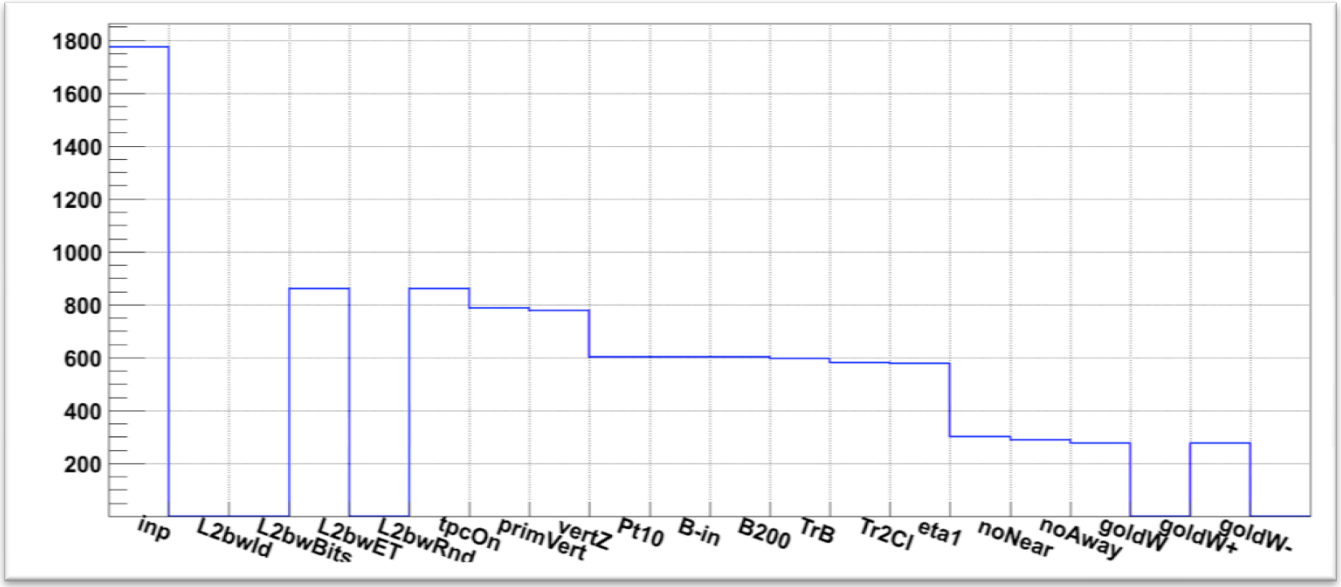
Reconstruction Efficiency Estimation

- W Reconstruction Efficiency
  - Trigger Efficiency
  - Vertex Finding Efficiency
  - Tracking Efficiency
  - Algorithm Efficiency

$$\varepsilon^{tot} = \varepsilon^{trig} \times \varepsilon^{vert} \times \varepsilon^{trk} \times \varepsilon^{algo}$$

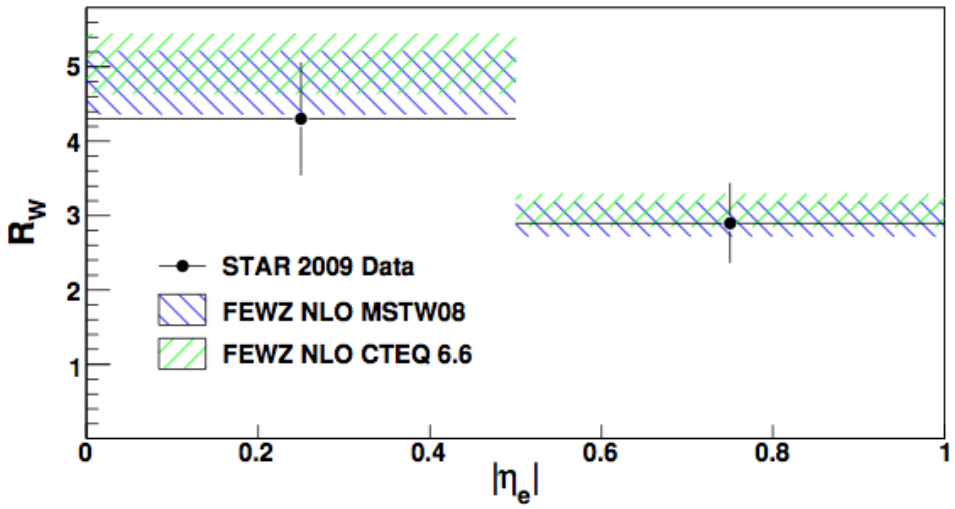
=> To be defined, ongoing work

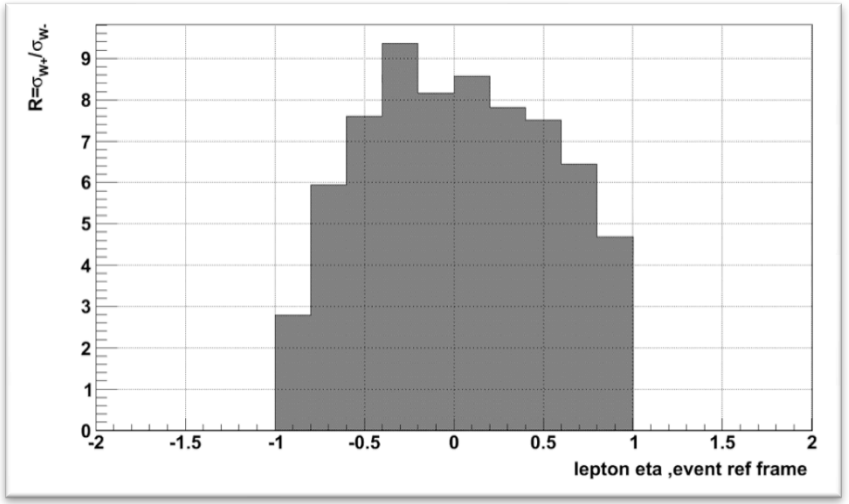
- W^- Embedded data. 1st look : 53 files / 633 => 300 W^-



Summary / Outlook

- W boson program
  - Mid-rapidity: First proof-of-principle measurement of R_W in Run 9
  - Critical: Measurement of W^+ and W^- R_W and charge asymmetry as a function η_e
  - Potential to provide additional constrain from RHIC program for unpolarized quark distributions for $0.05 < x < 0.5$
  - => Preliminary results for DIS conf. for run 12



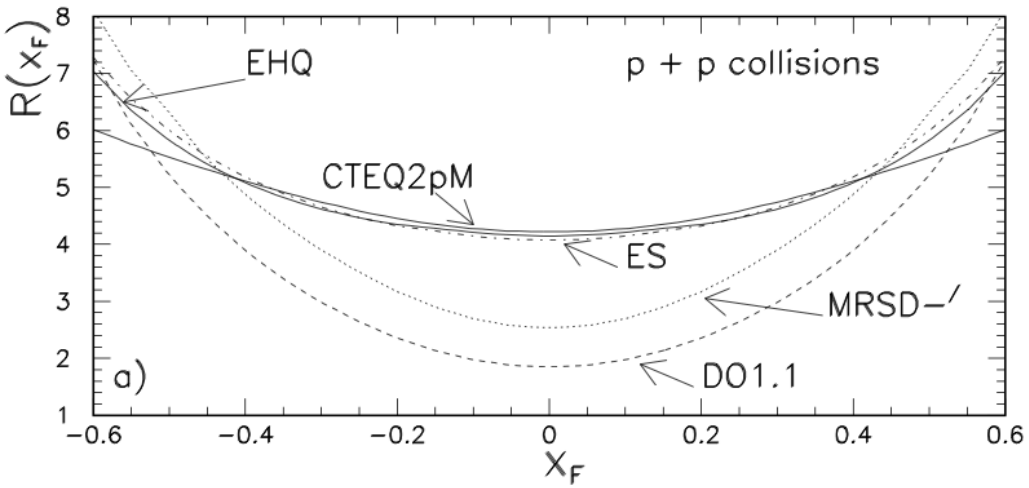


SPARES

Motivation

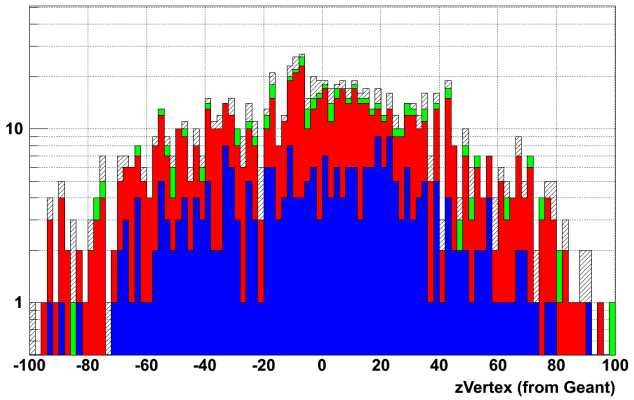
- Studying the unpolarized sea quark d/u¯ flavor asymmetry
- The ratio of the W to W¯ crosssection, RW =σW+/σW−, is the observable of interest for the d/u¯ flavor asymmetry
- Being sensitive to the d/u¯ asymmetry at Q = MW
- Probe the valence and sea structure of the anti-anquarks in the nucleon
- Independant measuremtn of for DY at low Q^2

$$R(x_F) \equiv \frac{\frac{d\sigma}{dx_F}(W^+)}{\frac{d\sigma}{dx_F}(W^-)} = \frac{u(x_1)\bar{d}(x_2) + \bar{d}(x_1)u(x_2)}{\bar{u}(x_1)d(x_2) + d(x_1)\bar{u}(x_2)}.$$



W- Embedded Z vertex

zVertex of all events
zVertex of events that satisfy trigger
zVertex of events that w/ good vertex
zVertex of events that pass W cuts



- Charge Separation Hyperbola Corrected (Track p_T)