The Measurement of W+charm Production with SLT Tagging Method

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Method II Workshop

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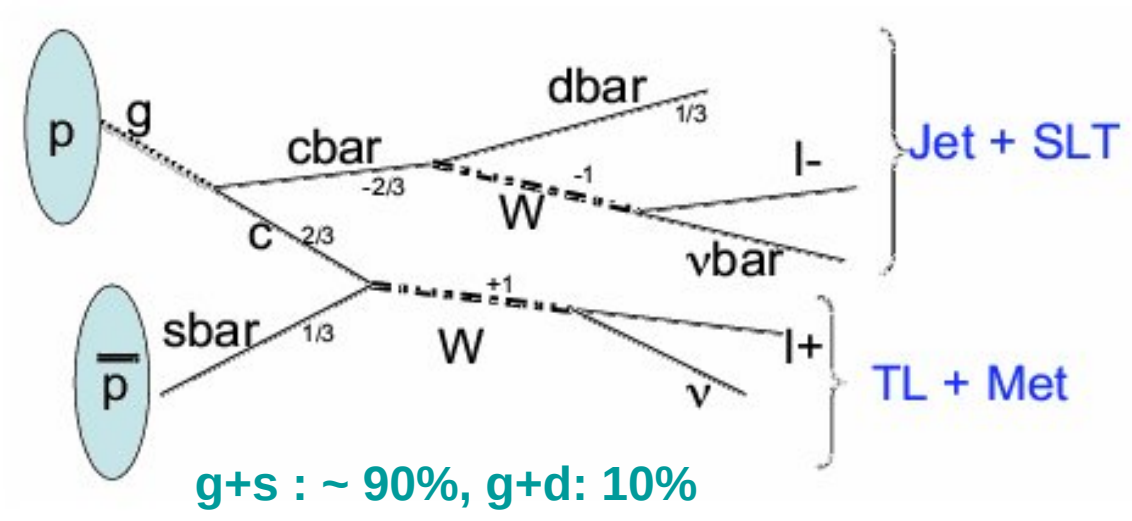
Motivation

- **Wc inclusive cross section has not been measured before**

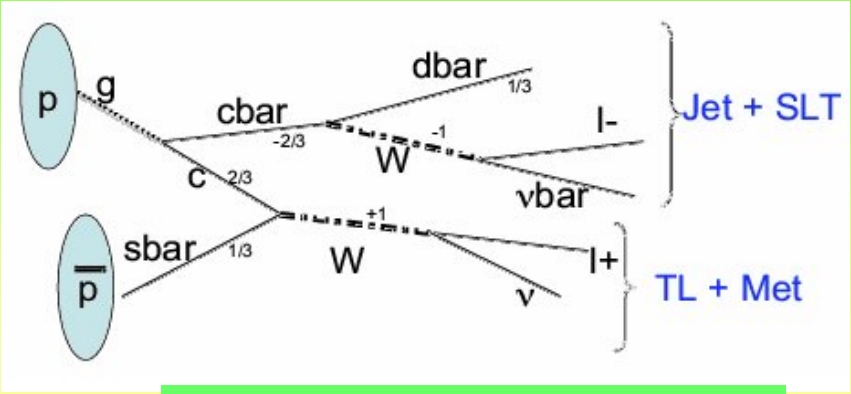


- probe the parton density function: g(x), s(x)

- Vcs matrix element

- **Given the charge correlation between the tight lepton and the soft muon, SLT tagging method is a handy tool**

Overview of the Analysis



SLT and TL charge are anti-correlated

⇩

Expect more opposite sign (SLT-TL) events for Wc sample

W+jets data sample

⇩

Apply SLT tagger, count $\Delta N = N_{OS} - N_{SS}$

Define charge asymmetry:

(os/ss: opposite/same sign)

$$A = \frac{N_{OS} - N_{SS}}{N_{OS} + N_{SS}}$$

Estimate ΔN_{bkg} from backgrounds

(W+LF, QCD, DY, etc)

Need to estimate both
- **# of background events**
- **Charge asymmetry A_i^{bkg}**

Wc: $\Delta N_{Wc} = \Delta N - \Delta N_{bkg}$

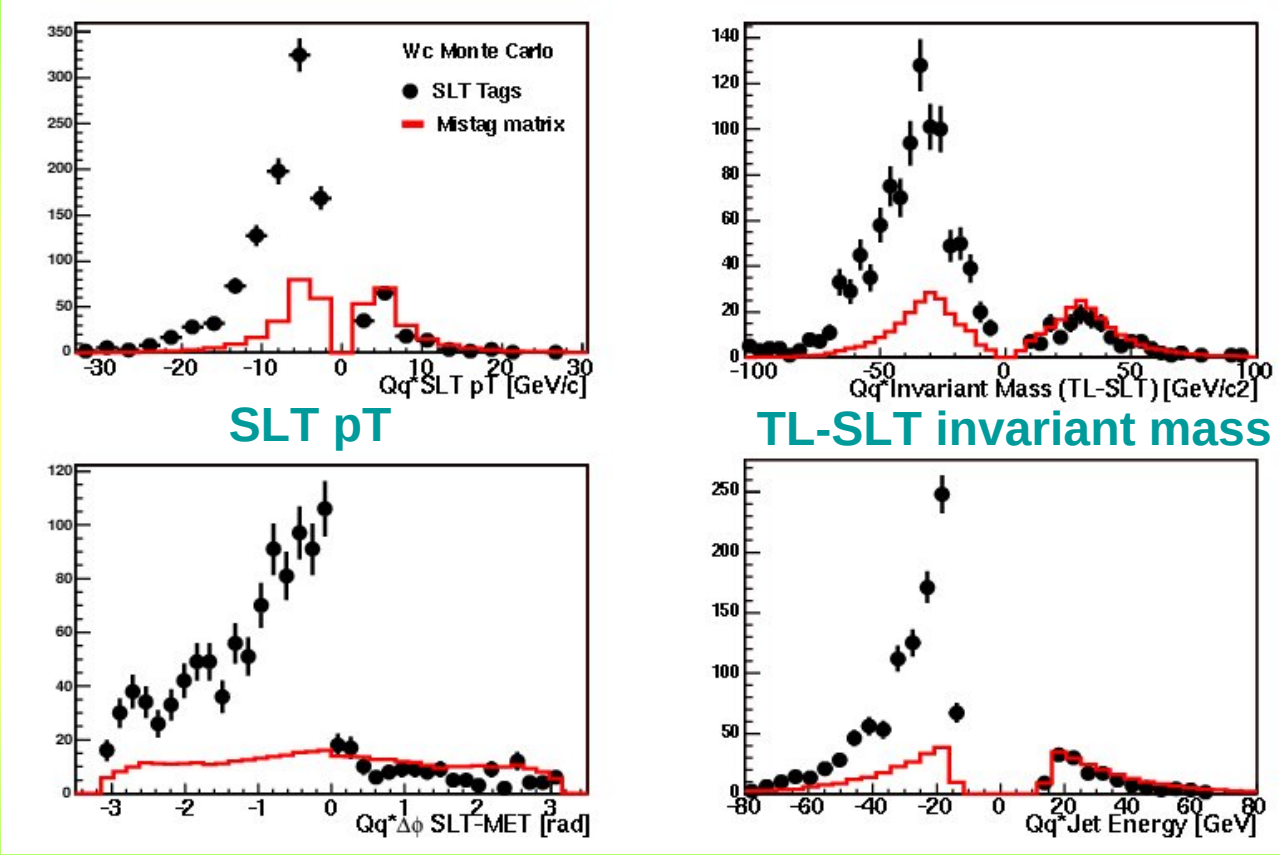
↓

Expected # of Wc in the sample

$\Delta N_{Wc}/A_{wc}$

Wc MC sample

- Use ltop0a + ltop4a (Gen5)
  - A = 0.743 ± 0.011
  - Will update with Gen6 samples
- Kinematic plots
  - Signed by $Q_{TL}*q_{SLT}$
  - More Opposite sign events



SLT pT

TL-SLT invariant mass

dϕ(SLT,MET)

SLT jet Et

Data Sample and Event Selection

- Data sample: bhel, bhmu of 0d+0h+0i
  - integrated luminosity ~1.2 fb^{-1}
- Event Selection
  - Events with W+1, W+2 jets, standard cuts in top group except
    - Jet Et > 10 GeV
      - Increase acceptance for charm jets
    - MET > 25 GeV
      - Increase statistical significance
        - » Lower non-W and Z background
  - At least one SLT tag
    - Same tagger used in ttbar Xs analysis with SLT (note 8482)
- 1169 tagged events, $N_{OS} - N_{SS} = 193$.

W + Light Flavor

- **The number of W+LF events**
  - **Apply fake matrix to taggable tracks in data**
  - **Subtract QCD contribution (at pretag level)**
    - **QCD fraction determined from MET-iso plane**
  - **Deduct the heavy flavor components of the matrix**

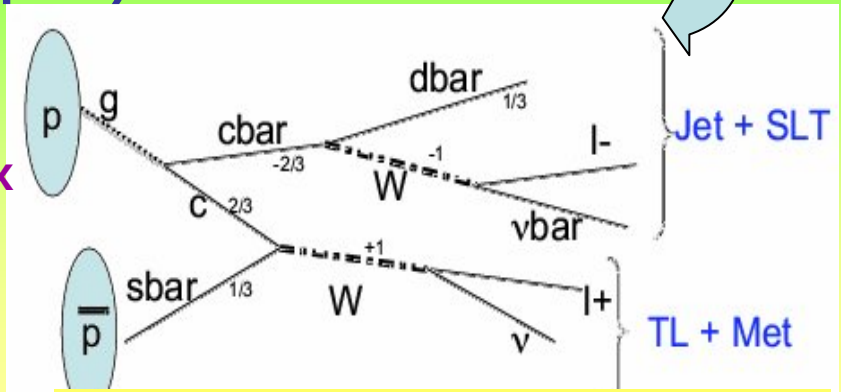
$$N_{LF} = N \otimes FM \times (1 - F_{QCD})(1 - F_{HF})$$

Sample	N_{FM}[events]	F_{nonW}	F_{HF}	N_{LF} [events]
e channel	610.9±61.9	0.047±0.009	0.214±0.033	457.6±19.2±10%(FM)
μ channel	424.0±42.4(*)	0.014±0.003	0.214±0.033	328.6±13.7±10%(FM)

Expected W+LF events

W + Light Flavor: Charge Asymmetry

- Use Alpgen W+njets MC sample (ptopNw)
  - Remove events with b or c quark
  - W vs tags, as well as W vs taggable tracks weighted by the mistag matrix
  - Cross-checked in data sample using taggable tracks



repalce c→u, s→d ⟹ wu production

Asymmetry (%)	MC		Data
TL type	Tags	Taggable	taggable
CEM	2.9±2.6	5.7± 0.2	6.4± 0.3
MUON	3.8± 2.6	1.9± 0.2*	1.9± 0.5

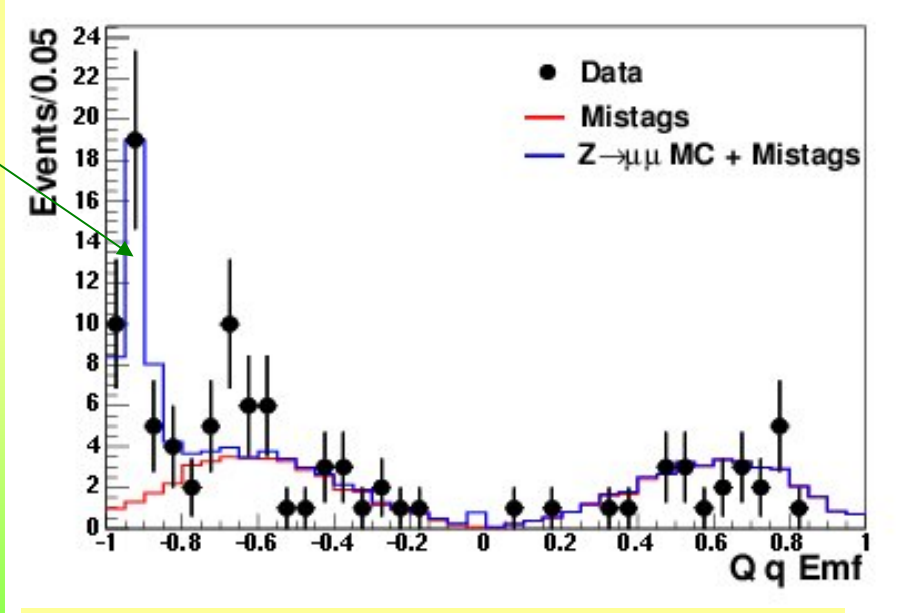
Charge asymmetry used for W+LF

- Do not expect difference b.t. tag and taggable
- Larger statistics

* The smaller A in muon than CEM channel is due to the dimuon removal (Y, Z).

DY

- Suppress DY events by following requirements
  - Remove events with invariant mass falling in
    - Y:[8,11], Z: [70,110]
  - Remove radiative muons
    - For emF>0.8, events with < 2 tracks in a 0.6 cone around the SLT jet
    - Opposite sign between TL and SLT
- Still some DY events pass
  - Determine R(out/in) in MC
    - R=0.474+/-0.039
  - Normalized to # of Z events in data sample
    - N_{DY} = 26.9+/-4.1
    - Deduct small contribution of Wc events under the Z peak
- Charge asymmetry
  - A = 0.621±0.037

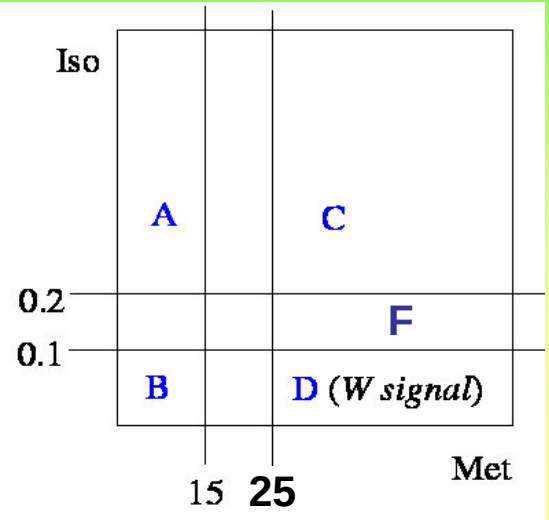


W+jets data, Region B(before removal)

Non-W QCD events

- **Determined from MET-iso plane of W+1&2 jet bin**
  - **Corrected the W+jets contamination in A/B/C determined from W+jets(ptopnw) samples**

$$N_D = \frac{N_B \cdot N_C}{N_A}$$



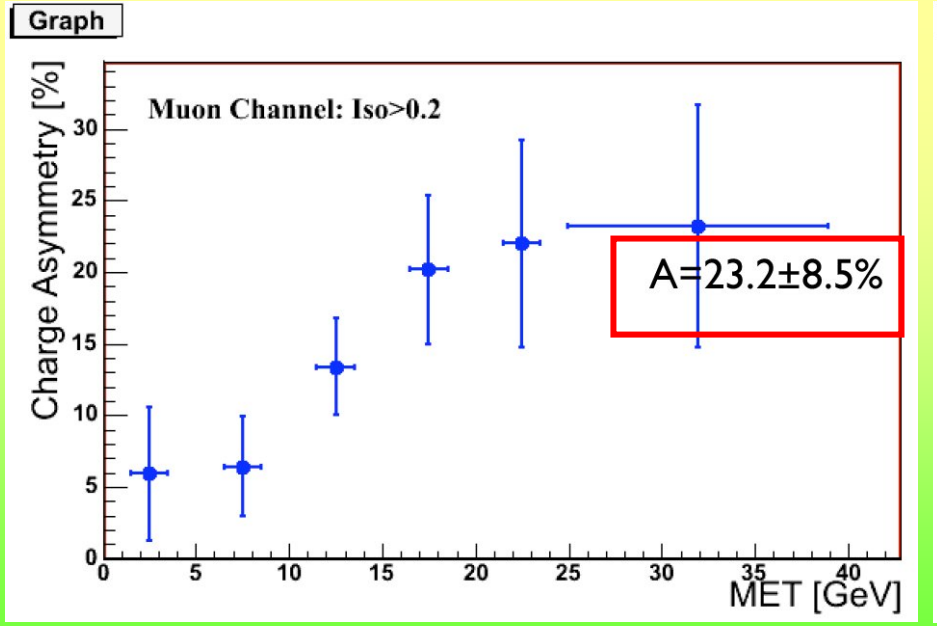
- **Systematic uncertainty drawn from a test in the F region**

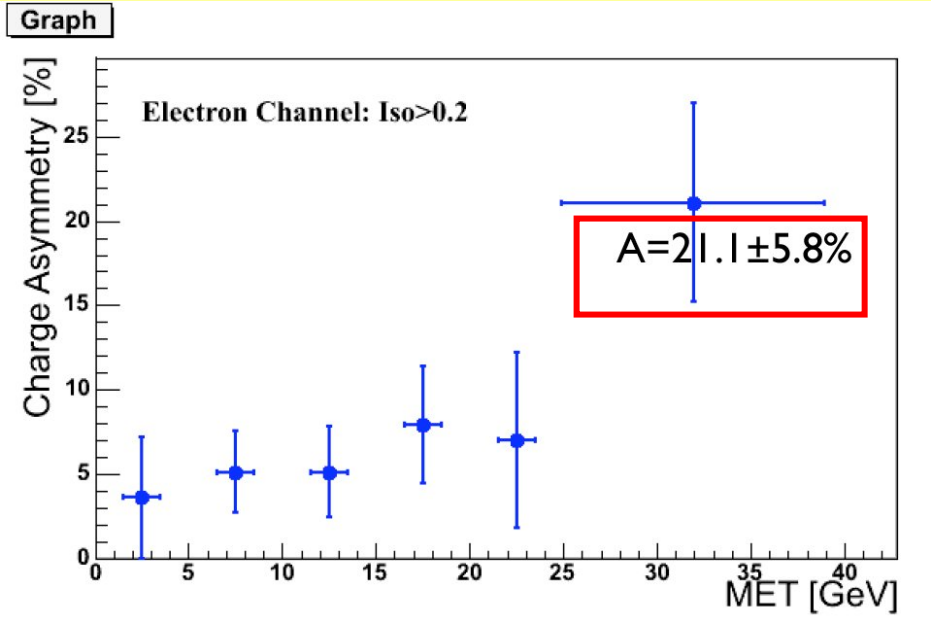
F-Test	e-ch, tags	e-ch, pretag	μ-ch, tags	μ-ch, pretag
Predicted	149±8	9580±48	28.0±2.4	4291±13
Observed	109	8035	34	3889
Δ [%]	-27±9	-16±1	-21±22	+9.4±1.5

- **QCD events found**
  CEM: 128 ± 8 ± 20%
  MUON: 18.6 ± 2.4 ± 20%

Non-W QCD : Charge Asymmetry

- The asymmetry is mainly due to bbbar and ccbar events
  - When TL and SLT are both from semileptonic decay
  - Higher MET favors more semileptonic decayed events in the sample
- Measured in data sample a function of MET
  - Use the asymmetry measured in C region (MET > 25 GeV)





Table

Physics process	events	asymmetry	OS-SS events
Fake, $Wb\bar{b}$, $Wc\bar{c}$, Wc	1016.5±101.6	-	-
Fake only: Wl.f (e)	457.6±(19.2)±(10%)	0.057±0.002	26.1±(1)±0.9±(10%)
Fake only: Wl.f (μ)	328.6±(13.7)±(10%)	0.019±0.002	6.2±(0.26)±0.66±(10%)
Non-W (e)	128±8±(20%)	0.211±0.058	27.0±7.4±(20%)
Non-W (μ):	18.6±2.4±(20%)	0.232±0.085	4.3±1.8±(20%)
Drell-Yan	43.3±7.0	0.621±0.037	26.9±4.1
Total Predicted	1206.4±106.4		90.5±11.2
Data	1196		193 (73 μ, 120 e)
Measured Wc		0.743±0.011	102.5±33.7(stat)±11.2(sys)

ΔN_{bkg}

ΔN

This is the measured OS-SS events from Wc

#Wc events = 137.9 +/- 45.3 +/- 15.1

Final Results

Acceptance and SLT efficiency

- Use Alpgen Wc+njets samples (stopw0-8)
- Combine e- and u-channel for each n-parton sample
- Sum the acceptances weighted by the cross sections

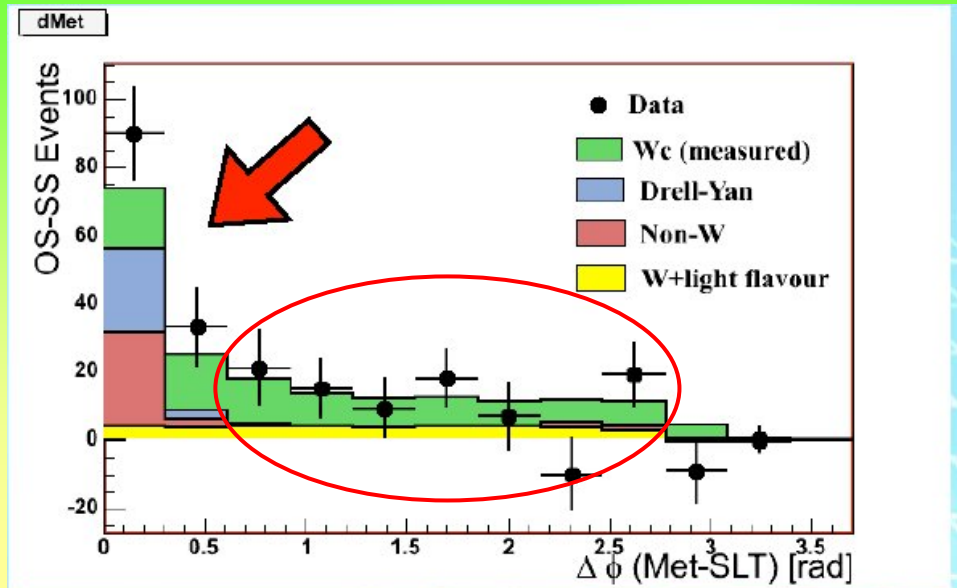
	Stopw0,5	Stopw1,6	Stopw2,7	Stopw3,8	total
Xs_Weight	0.80490	0.16350	0.02700	0.00470	
W+1,2 jets	0.00381	0.00695	0.00460	0.00154	0.00433
Uncertainty*	0.00007	0.00011	0.00009	0.00004	0.00006

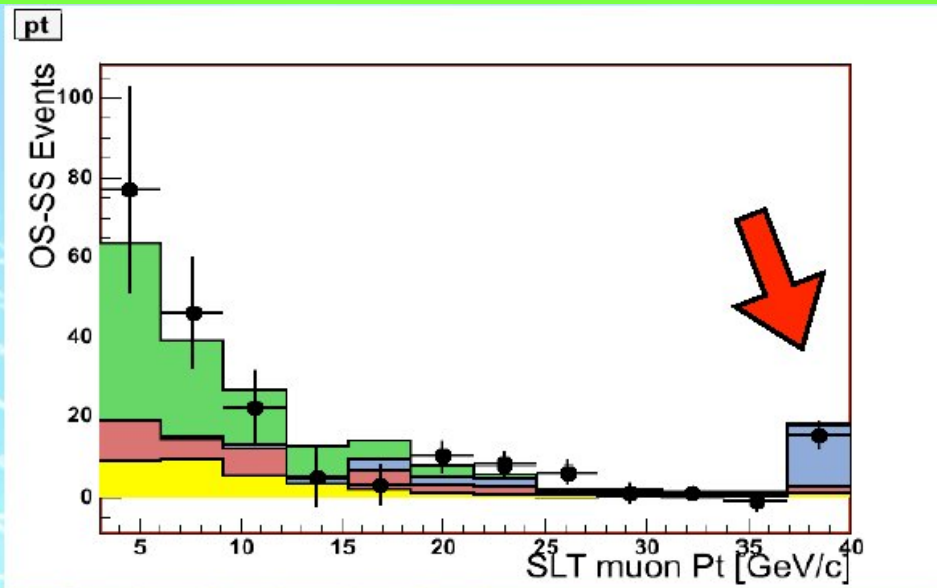
* Statistical only

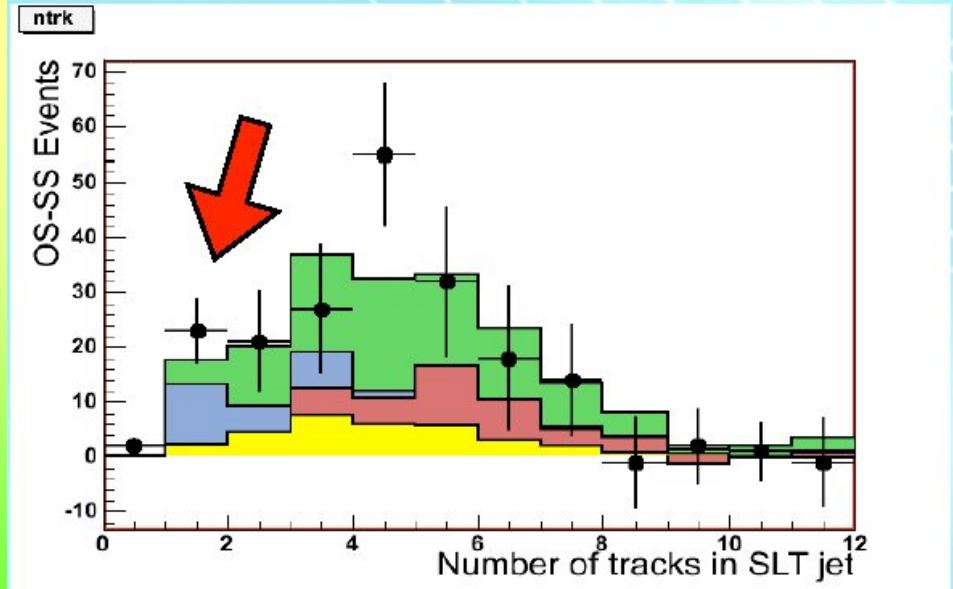
$$\sigma_{WC} = \frac{N_{data}^{OS\text{-}SS} - N_{bkg}^{OS\text{-}SS}}{A_{WC} \times Acc \times \int L}$$

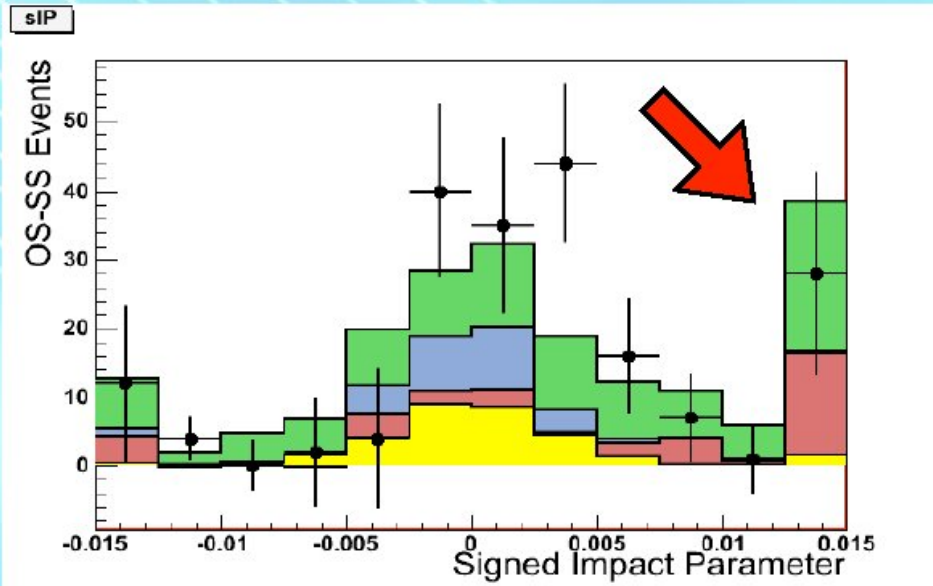
$$\sigma_{wc} = 26.5 \pm 8.7(stat) \pm 2.9(sys) \pm 1.6(lum)\ \mathrm{pb}$$

Kinematic Distributions









Underflow/overflow included in the 1st/last bin when applicable

Summary

- **The W+charm production cross-section has been measured in W+1,2 jet bin with SLT tag**
  - **MC generation cuts for charm: pT > 8 GeV, |Eta| < 3**

$$\sigma_{WC} = 26.5 \pm 8.7(stat) \pm 2.9(sys) \pm 1.6(lumi)\, pb$$

(preliminary result)

- **Total integrate luminosity of the analysis: 1.2 fb^{-1}**
  - **Projected uncertainty with 2 fb^{-1}**

$$\pm 6.7(stat) \pm 2.4(sys) \pm 1.6(lumi)\, pb$$

- **Still working on a few loose ends**
  - **Systematic uncertainties of acceptance, etc.**