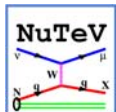


First Results from the NLO Charm Production Analysis at NuTeV

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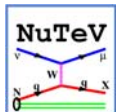
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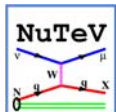
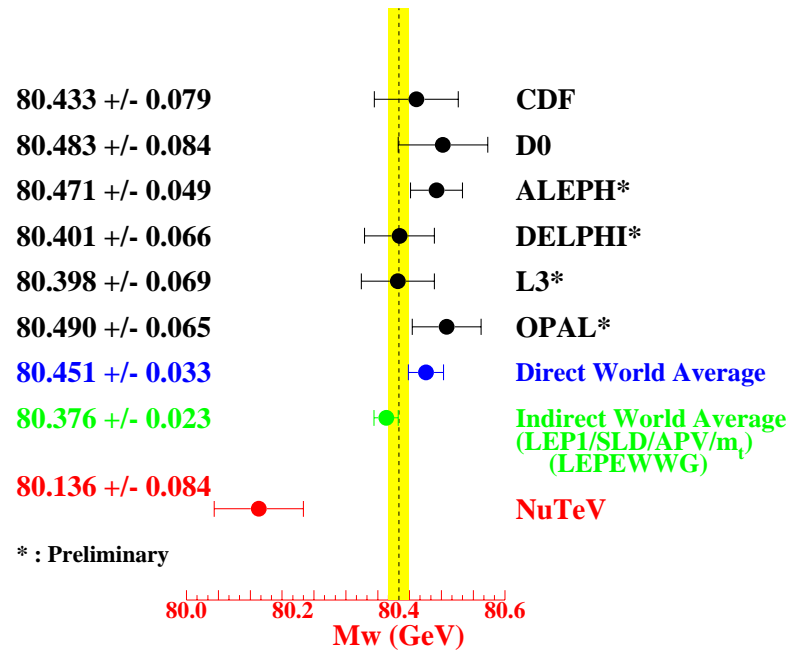
⁸University of Rochester, Rochester, NY



Some Context – What's NuTeV?

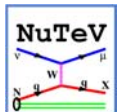
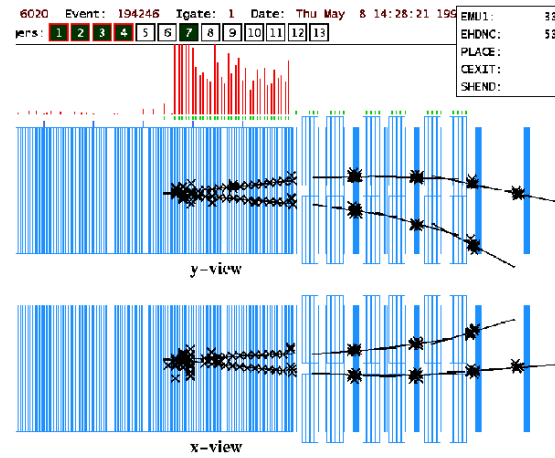
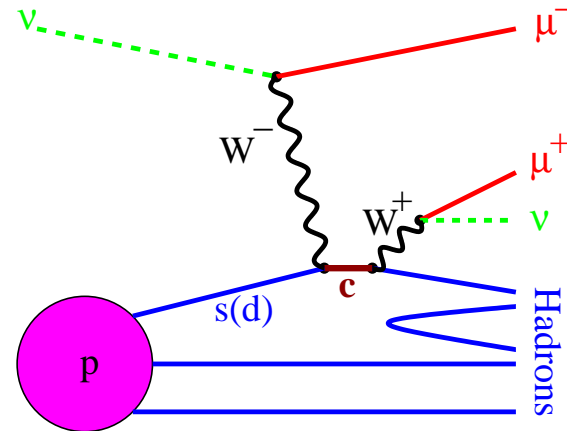
- ν -N DIS ($\langle E_\nu \rangle \sim 120\text{GeV}$)
- FNAL '96-'97 fixed target run
- Separate ν and $\bar{\nu}$ beams
- Continuous test beam calibration
- Recently published EW result

(G. Zeller et al: PRL 88 (2002) 091802)



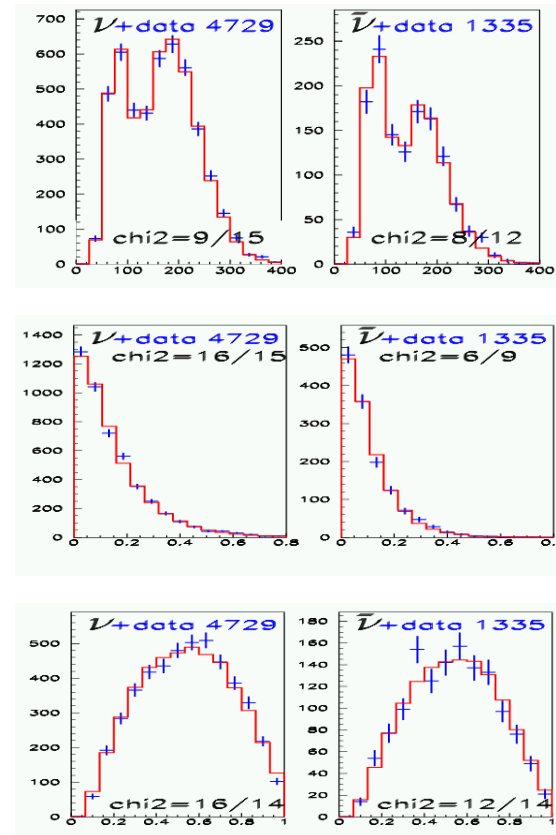
Charm Production \Rightarrow Dimuons

- CC νN makes charm
 \rightarrow fragmentation
 \rightarrow semileptonic decay to μ
- Measure charm mass
- Direct look at strange sea
- NuTeV can look at s/\bar{s}
- Very clear signal

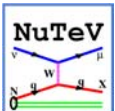


Forward Dimuon Cross Section Table

- $\frac{d\sigma(\mu\mu; E_{\mu 2} > 5 \text{ GeV})}{dx dy}$
- Cross section of observable dimuons
- Used LO MC to correct for detector smearing
- LO MC fits data very well
- Model independent representation of data
- Available for use in global fits

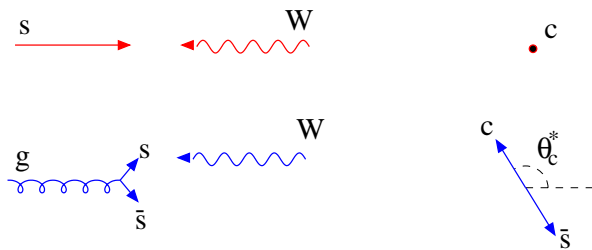


(M. Goncharov et al:PRD64 (2001) 112006)

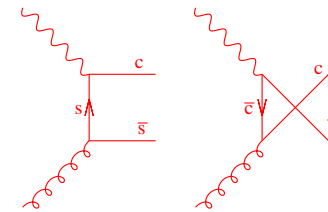


NLO

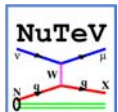
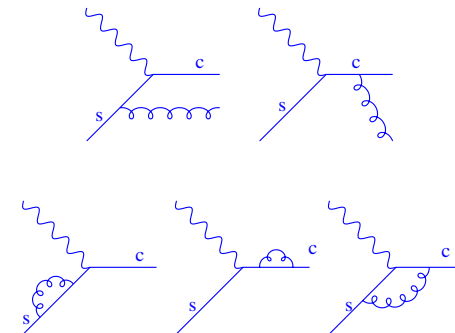
- Large gluon sea \Rightarrow NLO
- m_c , s sea have physical meaning outside our LO model
- Fragmentation no longer factorizes
- Dimuon acceptance depends on z , charm p_{\perp}



Next To Leading Order
(gluon initiated)



Next To Leading Order
(quark initiated)

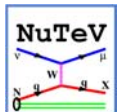
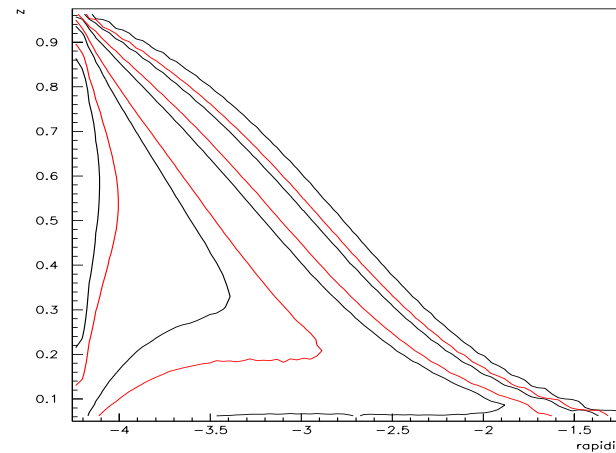
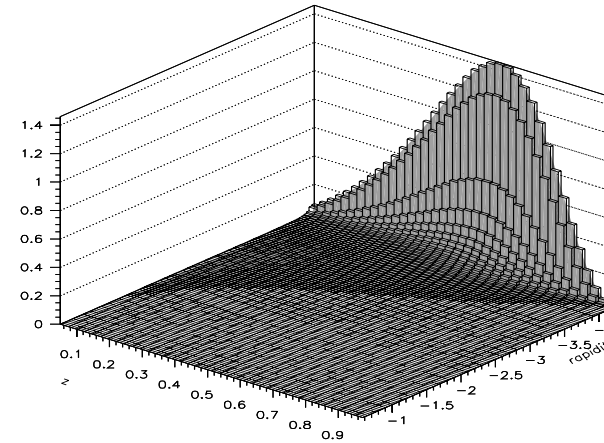


DISCO

- **DIS Charm Code**

(S. Kretzer et al; PRD65 (2002) 074010)

- Includes all NLO diagrams
- $\frac{d\sigma_c}{dx dy dz d\eta_c}$
- z correctly convolved
- Charm p_{\perp} dependence as η_c
- Bins z, η_c
- 2D numerical integration is slow



Fit Procedure

$$\frac{d\sigma_{charm}(E_\nu, x, y; m_c, \kappa, \bar{\kappa}, \alpha, \bar{\alpha}, \epsilon)}{dxdy} \cdot EMC(x) \cdot B_c \cdot \mathcal{A}(E_\nu, x, y; \epsilon, m_c) \quad \boxed{\text{fit}} \Rightarrow \quad \frac{d\sigma_{2\mu}(E_\nu, x, y)}{dxdy}$$

$\frac{d\sigma_{2\mu}(E_\nu, x, y)}{dxdy}$ measured NuTeV dimuon cross section

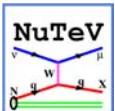
$\frac{d\sigma_{charm}(E_\nu, x, y; m_c, \kappa, \bar{\kappa}, \alpha, \bar{\alpha}, \epsilon)}{dxdy}$ NLO charm cross section, integrated over z and η_c .

It depends on the fit parameters: $m_c, \kappa, \bar{\kappa}, \alpha, \bar{\alpha}, \epsilon$.

$EMC(x)$ EMC correction

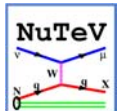
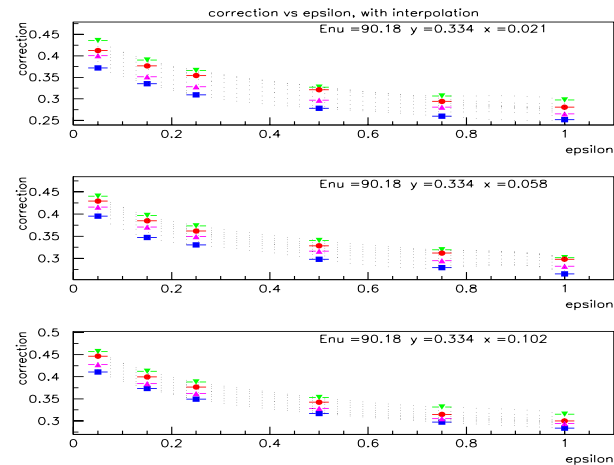
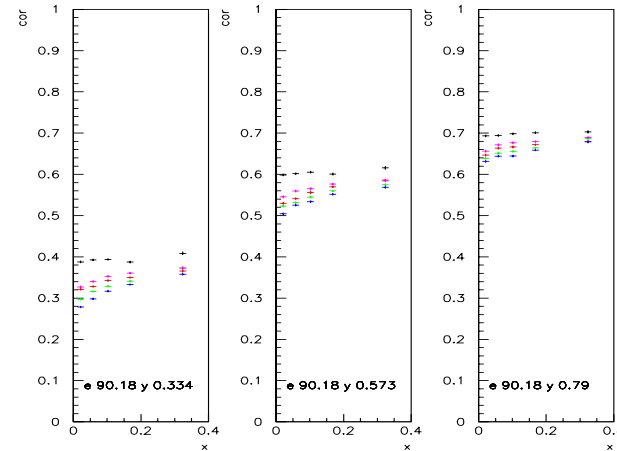
B_c is the semileptonic branching ratio. The E531 value of 0.093 ± 0.008 is used.

$\mathcal{A}(E_\nu, x, y; \epsilon, m_c)$ is the acceptance function due to the 5 GeV cut on the muon from the semileptonic charm decay $\left(\frac{\mathcal{N}(E_{\mu 2g} > 5 \text{ GeV})}{\mathcal{N}(all)} \right)$.



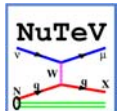
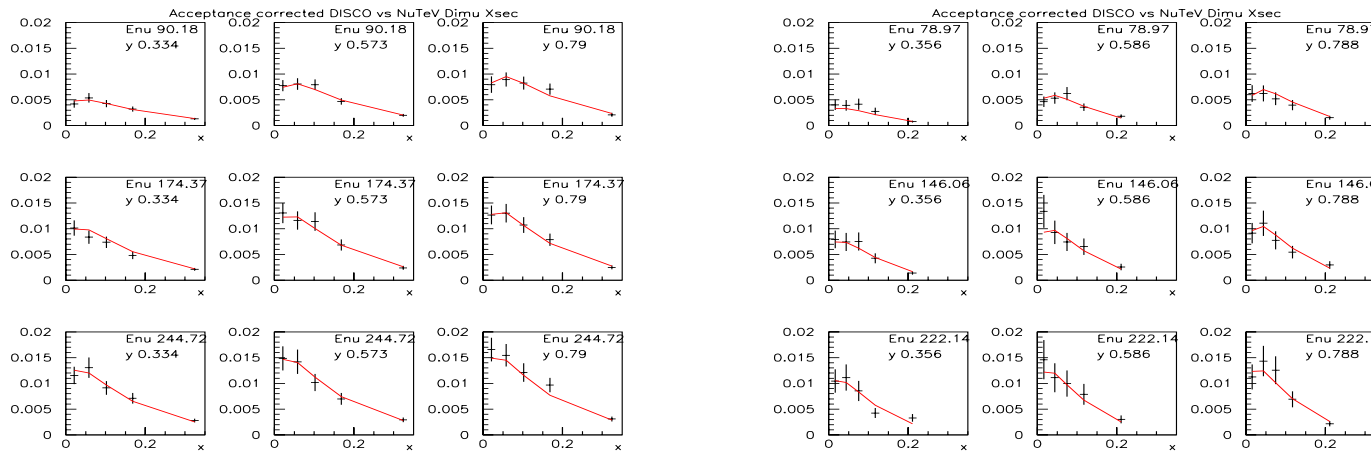
Acceptance Corrections

- $\mathcal{A}(E_\nu, x, y; \epsilon, m_c) = \left(\frac{\mathcal{N}(E_{\mu 2g} > 5 \text{ GeV})}{\mathcal{N}(\text{all})} \right)$
- Corrects for effect of energy cut on second muon
- Depends on charm mass and fragmentation
- Using Collins Spiller function
- DISCO is slow \Rightarrow must interpolate.



Preliminary Fit Results

| parameter | result | stat | table syst | interp | B_C | total uncert |
|----------------|---------|-------------|-------------|-------------|-------------|--------------|
| m_C | 1.46 | ± 0.24 | ± 0.05 | ± 0.06 | ± 0.02 | ± 0.25 |
| κ | 0.516 | ± 0.033 | ± 0.004 | ± 0.005 | ± 0.030 | ± 0.045 |
| $\bar{\kappa}$ | 0.511 | ± 0.038 | ± 0.007 | ± 0.005 | ± 0.038 | ± 0.055 |
| α | 0.73 | ± 0.47 | ± 0.07 | ± 0.04 | ± 0.52 | ± 0.70 |
| $\bar{\alpha}$ | 0.92 | ± 0.43 | ± 0.06 | ± 0.01 | ± 0.006 | ± 0.43 |
| ϵ | 0.203 | ± 0.126 | ± 0.023 | ± 0.030 | ± 0.003 | ± 0.132 |
| χ^2 / NDF | 36.2/38 | | | | | |



Strange Sea

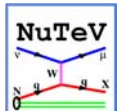
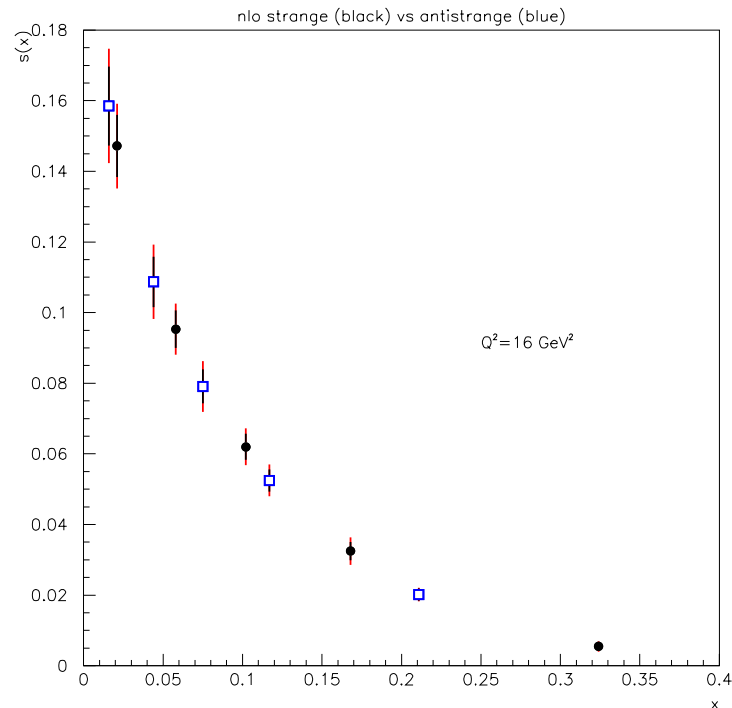
$$\kappa = 0.516 \pm 0.045$$

$$\alpha = 0.73 \pm 0.70$$

$$\bar{\kappa} = 0.511 \pm 0.055$$

$$\bar{\alpha} = 0.92 \pm 0.43$$

- $s(x) = \kappa \frac{\bar{u}(x) + \bar{d}(x)}{2} (1-x)^\alpha$
- $\bar{s}(x) = \bar{\kappa} \frac{\bar{u}(x) + \bar{d}(x)}{2} (1-x)^{\bar{\alpha}}$
- GRV94 PDFs
- $s(x), \bar{s}(x)$ consistent within errors

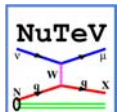
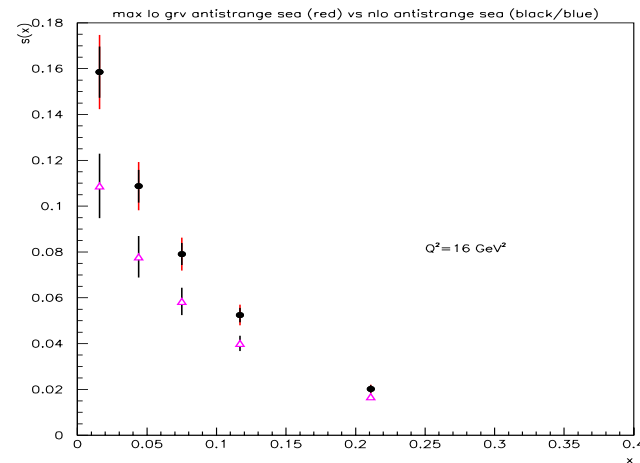
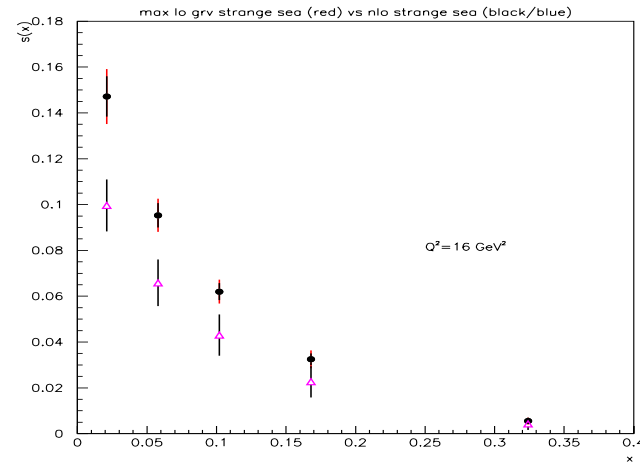


Comparisons with LO

- NLO strange sea is much larger
- In both NLO and LO the strange and antistrange seas are consistent within errors

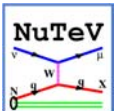
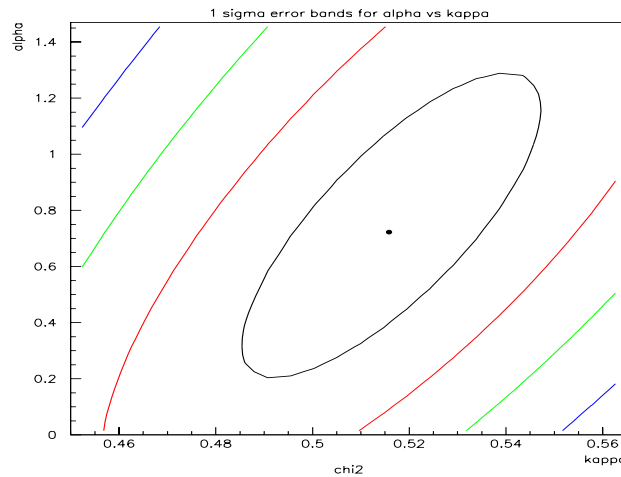
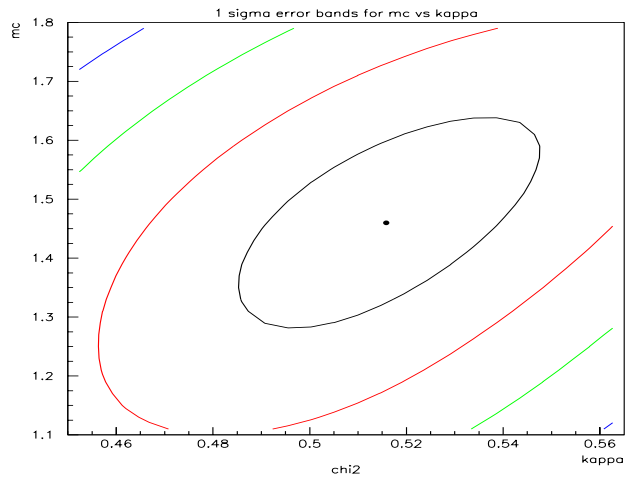
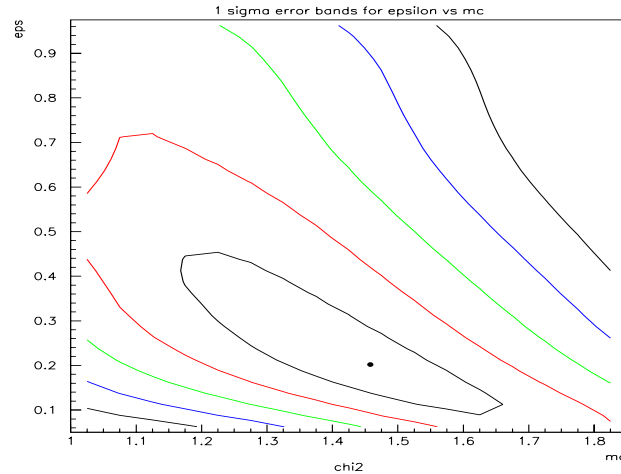
CCFR NLO:

- $m_c = 1.7 \pm 0.16$, $\kappa = 0.47 \pm 0.06$,
 $\alpha = -0.05 \pm 0.56$
- Not full NLO calculation
(A. O. Bazarko et al: Z. Phys. C65, 189
1995)



Correlations

- Charm mass and fragmentation ϵ are anti-correlated
- κ and m_c are correlated
- κ and α are also correlated



Conclusions & Next Steps

- Dimuon events provide a good means to look at the strange sea and charm production
- NLO effects are important
- Need to take z and η_c acceptance into account
- Strange and antistrange seas are consistent within errors

This is not the final word from us!

- Incorporate CCFR cross section tables (doubles statistics)
- Fit to tables using Peterson fragmentation, more PDF's
- Re-extract cross section table with NLO MC (check)

