NuTeV Strange/Antistrange Sea Measurements from Neutrino Charm Production

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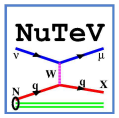
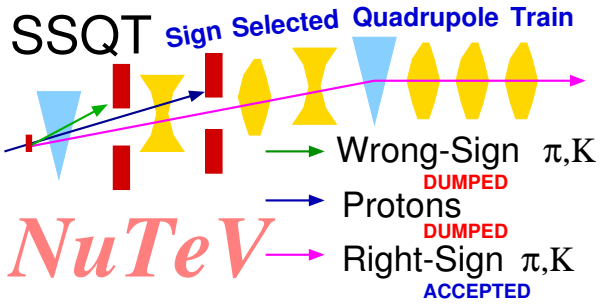
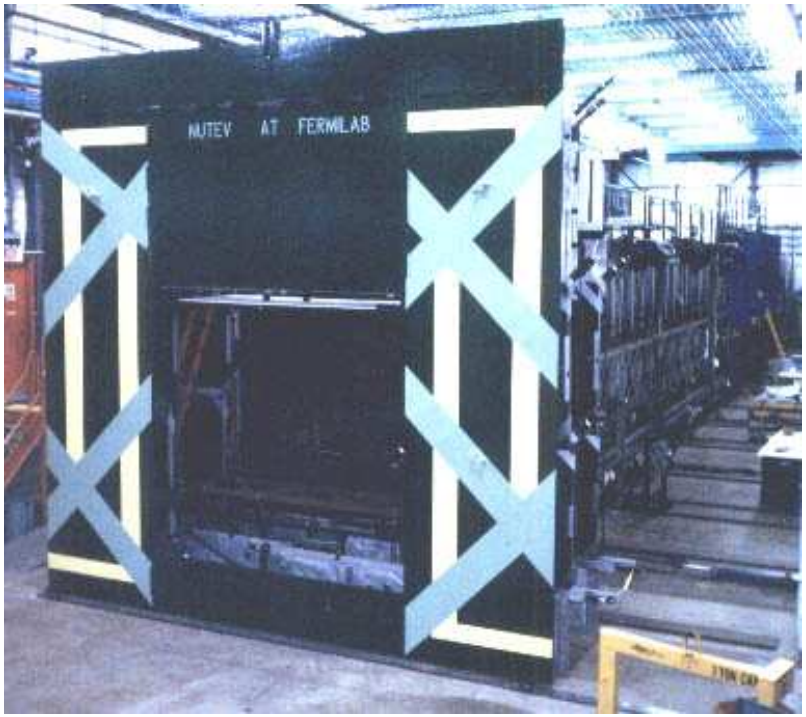
for the NuTeV Collaboration



What's NuTeV?

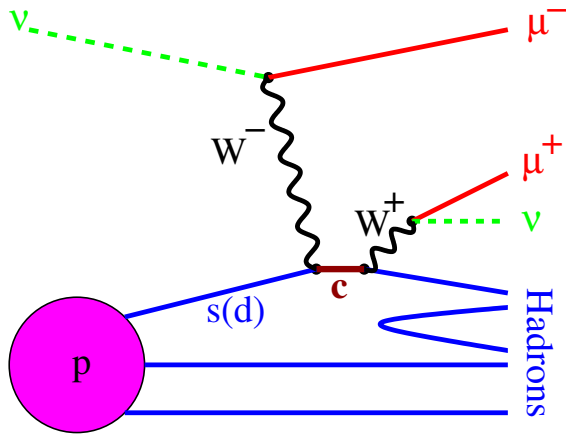
- ν-N DIS ($\langle E_\nu \rangle \sim 120 GeV$)
- FNAL '96-'97 fixed target run
- Detector calibration beam throughout run
- High purity, selectable ν and $\overline{\nu}$ beams

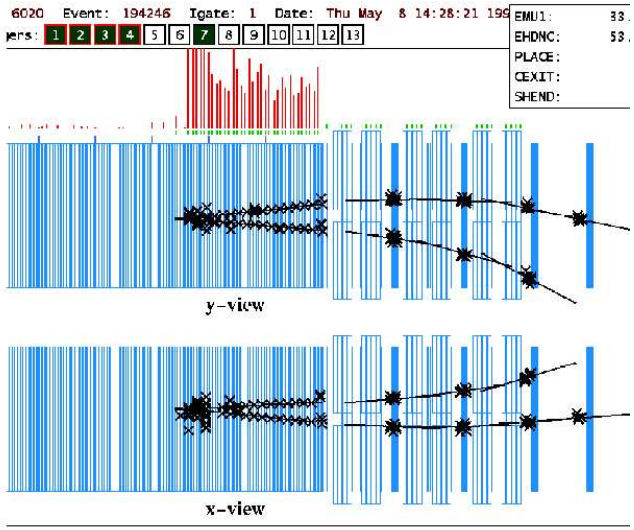




Charm Production ⇒ Dimuons

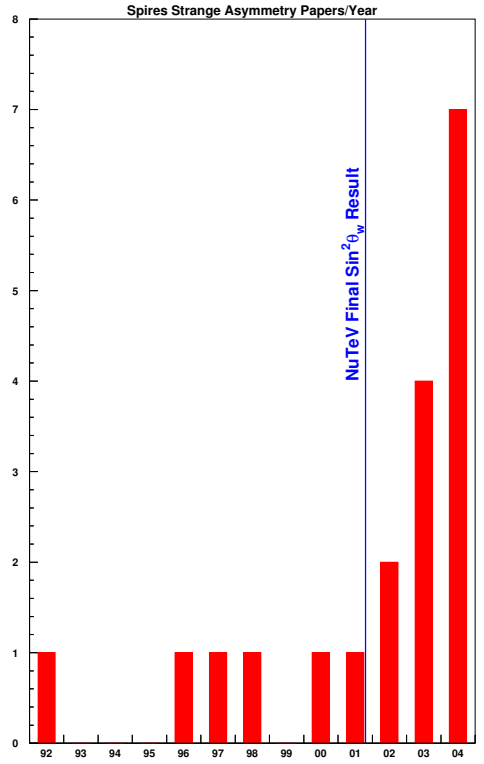
- CC νN makes charm
  $\longrightarrow$ fragmentation
  $\longrightarrow$ semileptonic decay to μ
- Very clear signature
- Direct look at strange sea
- With sign selected beam NuTeV can look at $s(x)$, $\overline{s}(x)$ independently
- Can also study charm mass, fragmentation





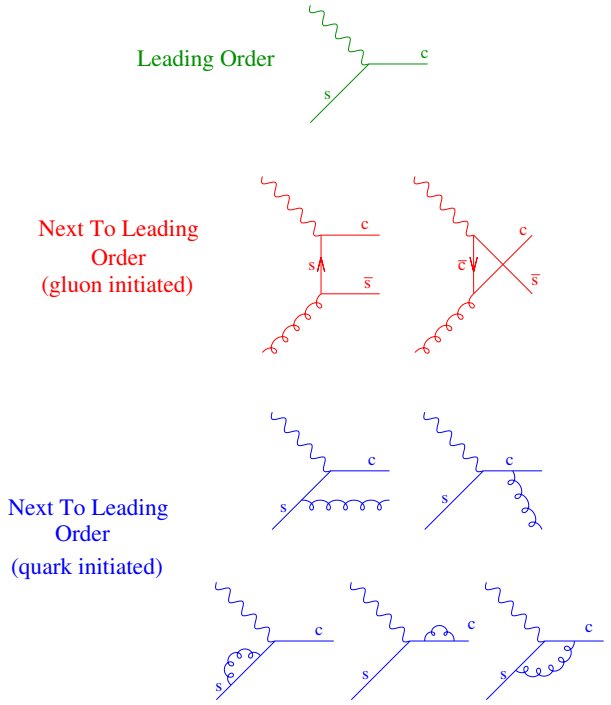
Some background...

- Original $\mu\mu$ cross section result
  - Goncharov et al: PRD64 (2001) 112006
  - Model independent description of data
  - Intended for global fitting use
- NuTeV final $\sin^2\theta_W$ result
  - Zeller et al: PRL 88 (2002) 091802
  - 0.22773 ± 0.00135 (stat) ± 0.00093 (syst)
  - $3\ \sigma$ from SM. prediction
  - $s - \overline{s}$ asymmetry popular explanation
  - $\int_0^1 x\ [s(x) - \overline{s}(x)]\ dx \sim +0.0068$ required



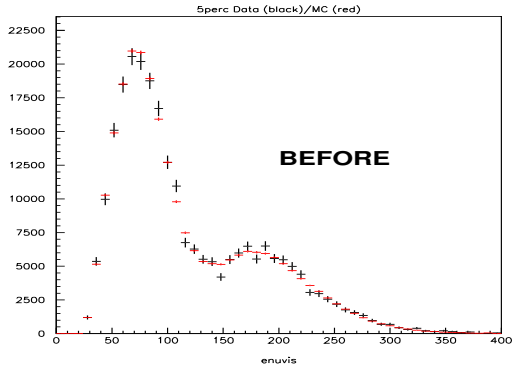
My Objective: NLO dimuon analysis

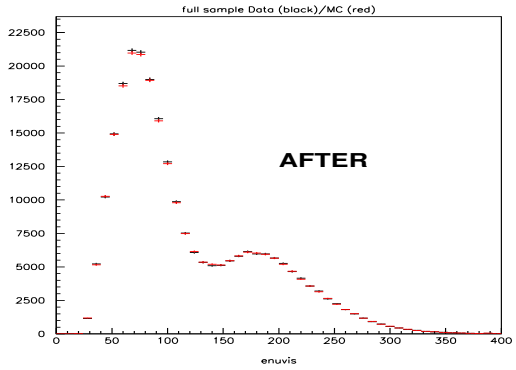
- NLO strange sea of global interest
- Large gluon contribution
- Fragmentation requires convolution integral
- use DISCO (S. Kretzer, F. Olness, D.M.; PRD65 (2002) 074010)
- Must fit to cross section tables
- Have re-analyzed data in preparation for finalizing NLO results



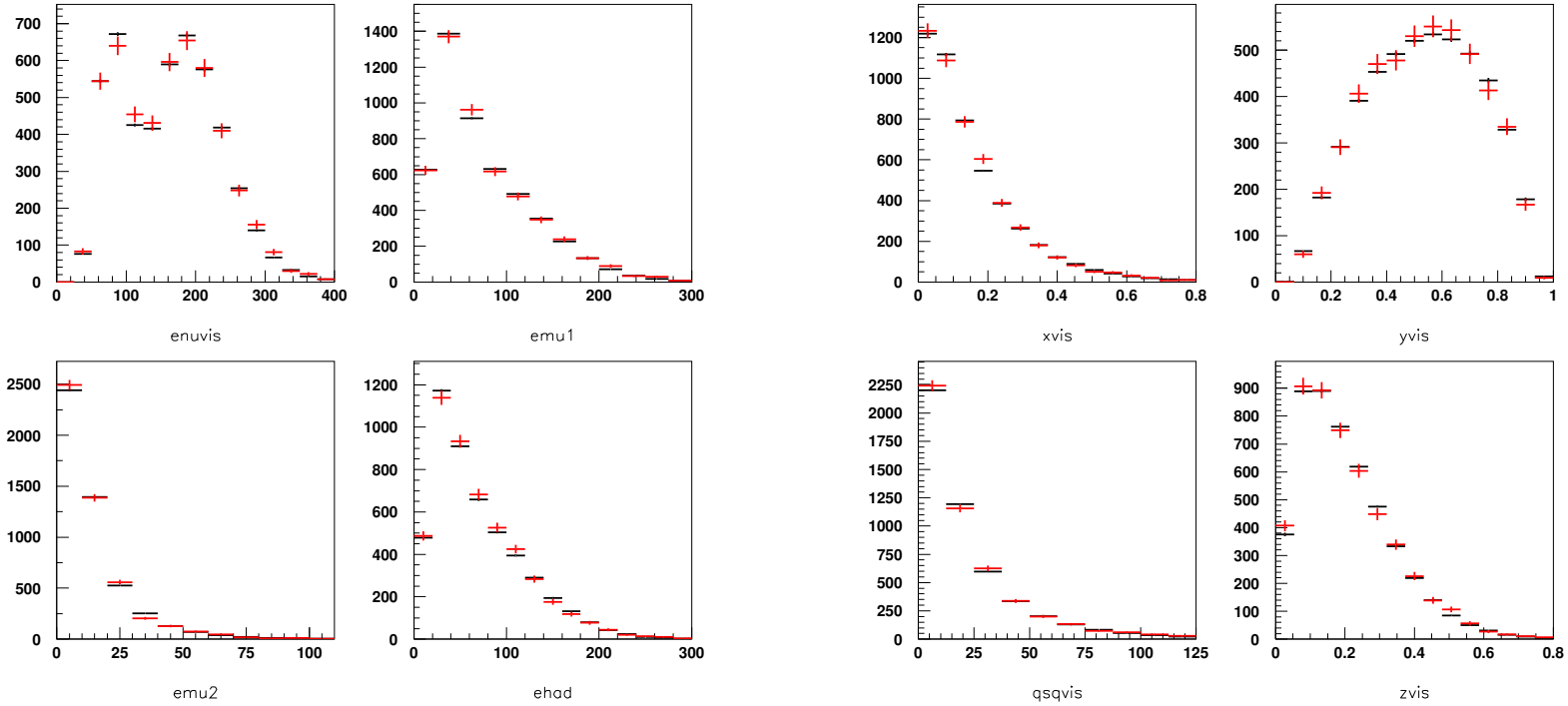
Improvements to Analysis

- Measure dimuon cross section relative to inclusive CC data
- Relied on 5% prescaled inclusive sample
- Moved to 100% sample
- Discovered subsample (0.4%) of events had leaked into 5% unprescaled
- Affects normalization & results
- Fixed! $\Longrightarrow$ More accurate result!



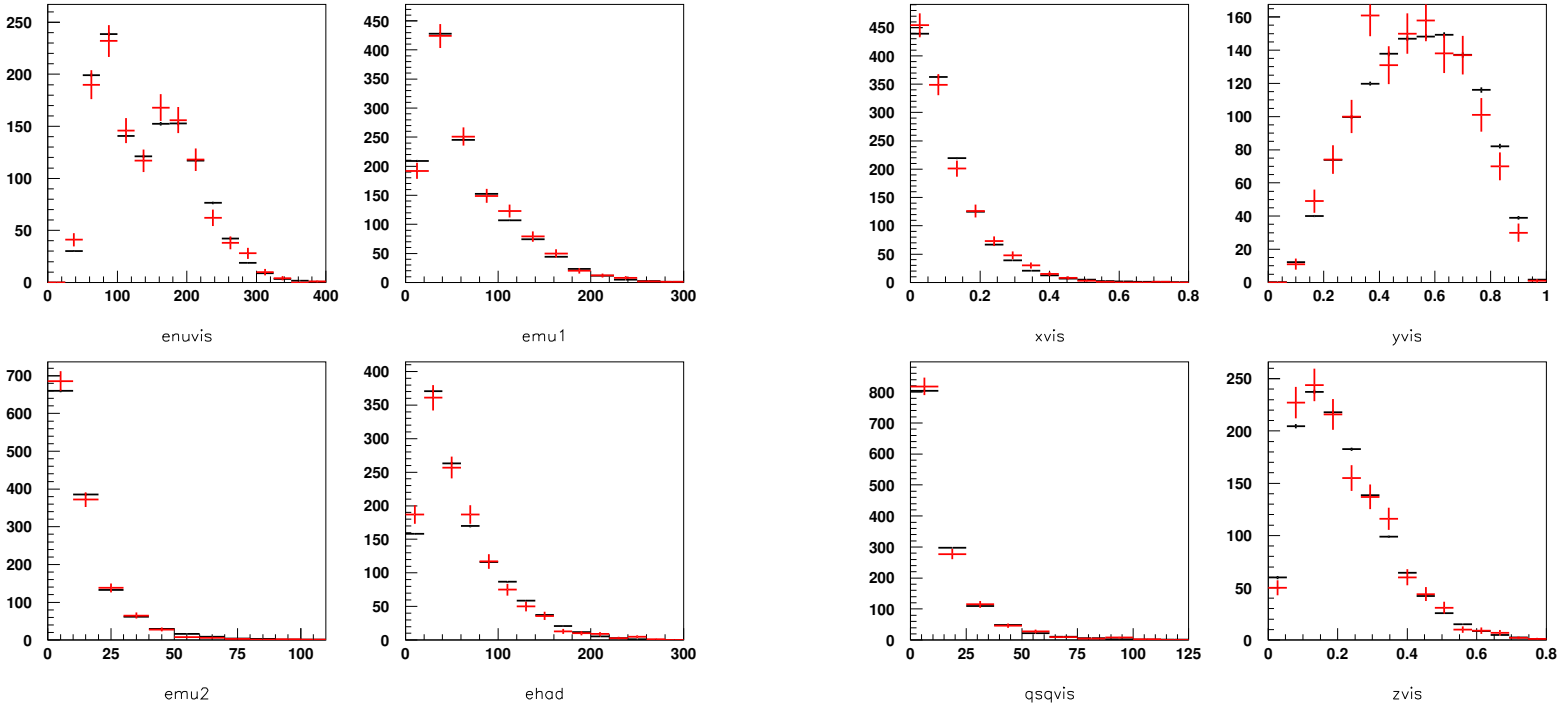


Data/MC Agreement: Neutrinos



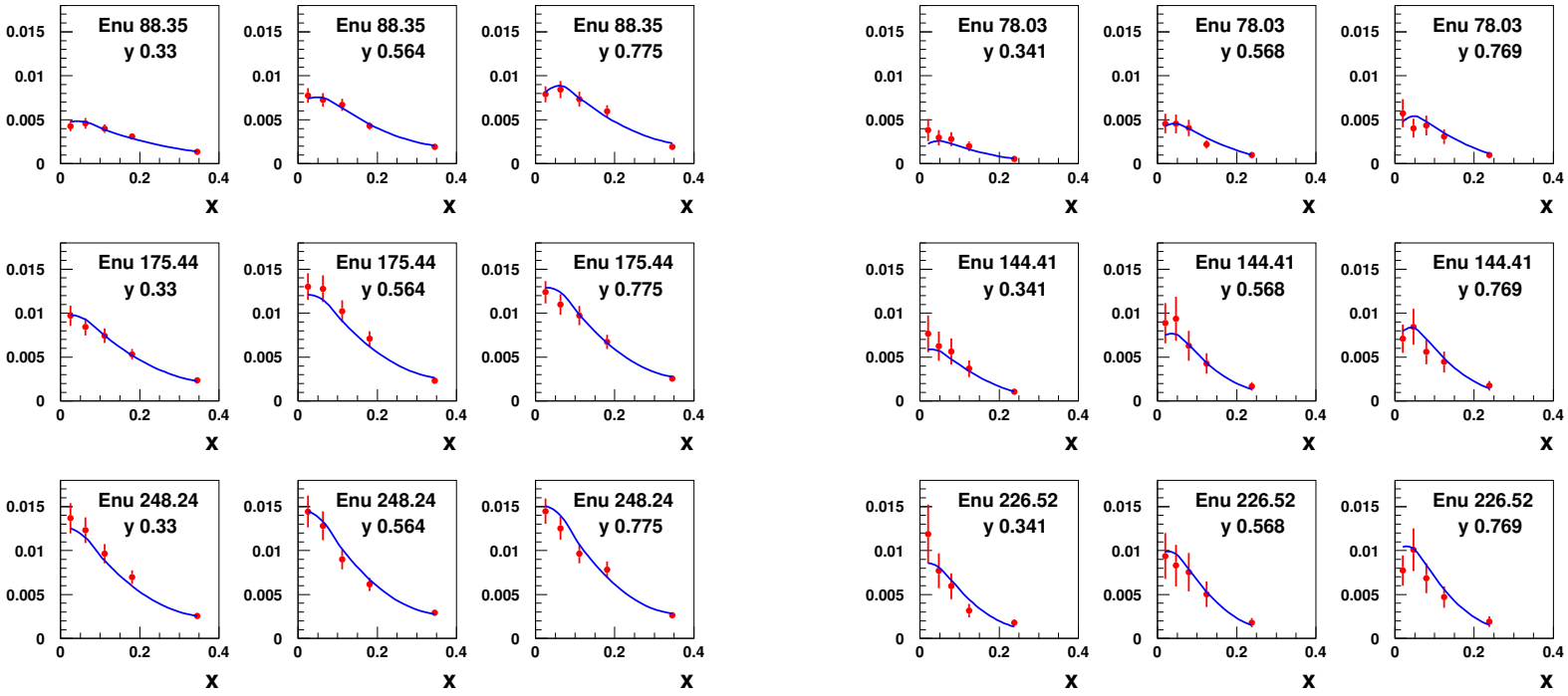
- Red points are data, black is MC

Data/MC Agreement: Antineutrinos



- Red points are data, black is MC

New Preliminary Dimuon Cross Section



- Plotting xsec vs x, normalized so $\frac{G_F^2 ME}{\pi} = 1$

Preliminary LO QCD fits

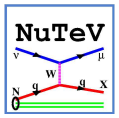
	m_c	ϵ	κ	$\overline{\kappa}$	α	$\overline{\alpha}$	B_c	S^-
Central Value	1.38	1.24	0.240	0.215	2.39	1.28	0.119	0.0009
Statistical Error	0.25	0.19	0.041	0.027	1.02	0.57	0.009	0.0012
ν π-K (15%)	0.02	0.24	0.013	0.017	0.03	0.04	0.007	0.0002
$\overline{\nu}$ π-K (21%)	0.02	0.07	0.001	0.012	0.03	0.29	0.001	0.0004
μ energy scale (1%)	0.08	0.12	0.032	0.015	0.32	0.31	0.008	0.0006
Had energy scale (0.5%)	0.01	0.05	0.005	0.003	0.03	0.04	0.000	0.0001
R_L (20%)	0.04	0.05	0.001	0.006	1.04	0.12	0.002	0.0002
MC statistics	0.05	0.01	0.009	0.003	0.50	0.00	0.000	0.0002
Flux	0.01	0.01	0.001	0.000	0.07	0.01	0.000	0.0000
Total Systematics	0.11	0.29	0.036	0.026	1.20	0.45	0.011	0.0008

- Based on new NuTeV total cross section
  - Use new extracted flux and bgpar parameterization
  - see Martin Tzanov's talk, this conf.
- Systematics still being finalized
  - NLO analysis will eliminate need for R_L systematic

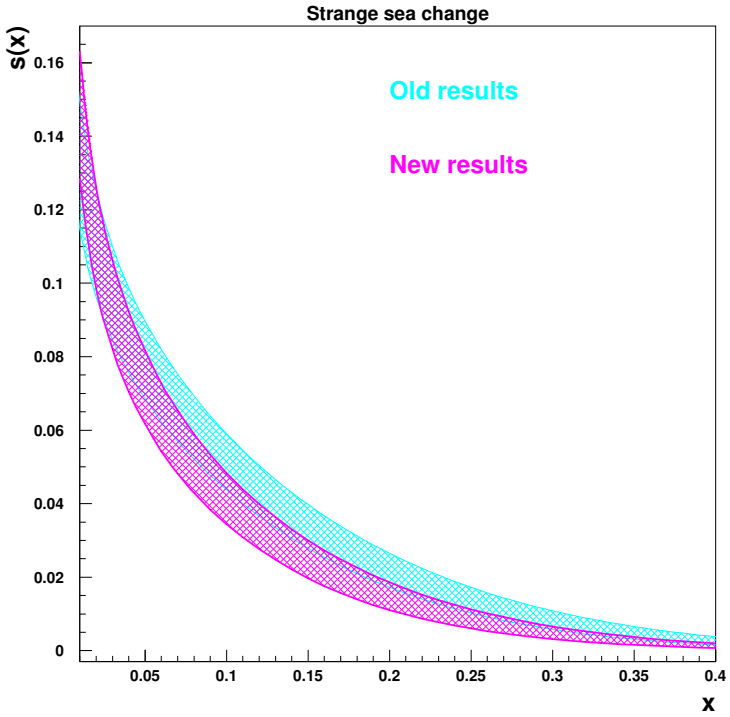
$$s(x) = \kappa(1-x)^{\alpha}\left(\frac{\overline{u}(x)+\overline{d}(x)}{2}\right)$$

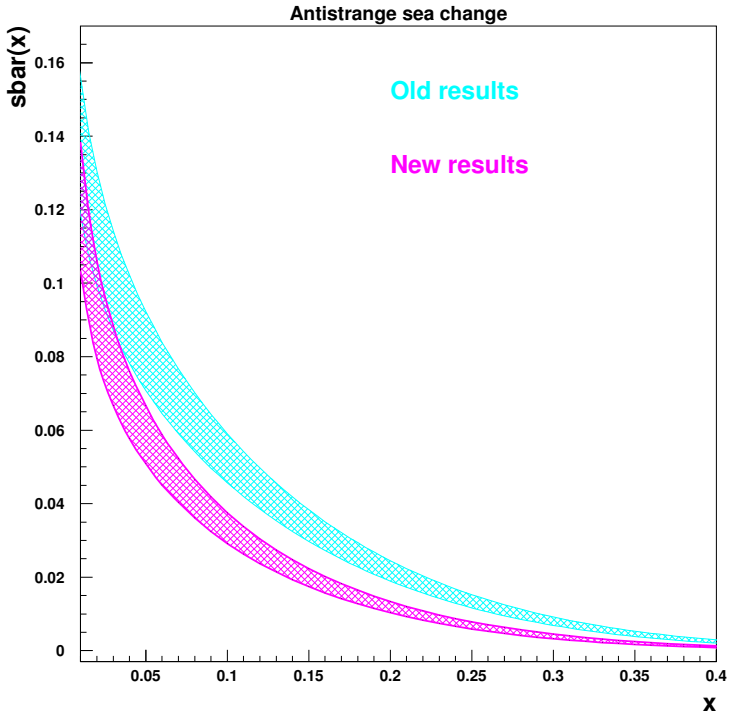
$$\overline{s}(x) = \overline{\kappa}(1-x)^{\overline{\alpha}}\left(\frac{\overline{u}(x)+\overline{d}(x)}{2}\right)$$

$$S^- \equiv \int x\ (s-\overline{s})dx$$



Effect of data fix on strange seas

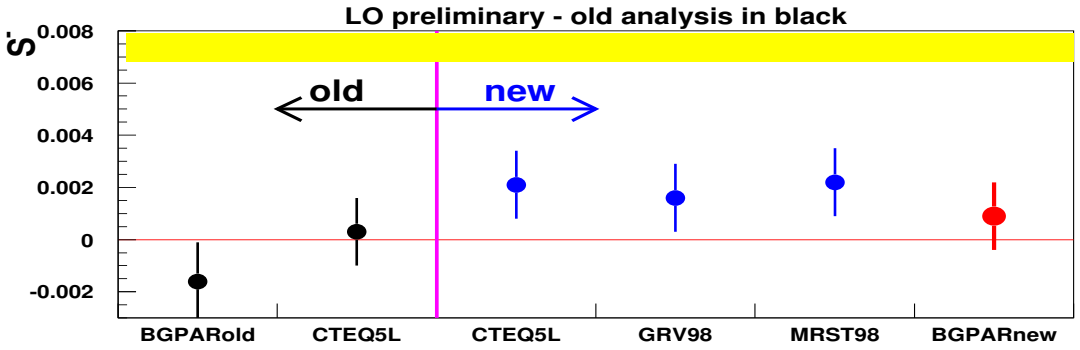




Strange Asymmetry and NuTeV $\sin^2\theta_W$

- NuTeV measures $R^- = \frac{\sigma^\nu_{NC} - \sigma^{\overline{\nu}}_{NC}}{\sigma^\nu_{CC} - \sigma^{\overline{\nu}}_{CC}}$
- From that $\sin^2\theta_W$ is extracted
  - Insensitive to sea quark uncertanties
  - But assumes symmetric strange sea
- QCD requires $\int (s - \overline{s})\, dx = 0$
- No QCD restriction on $S^- \equiv \int x\, (s - \overline{s}) dx$
- R^- correction for asymmetric strange sea is proportional to S^-
- $S^- \sim 0.0068$ required for agreement with S.M.

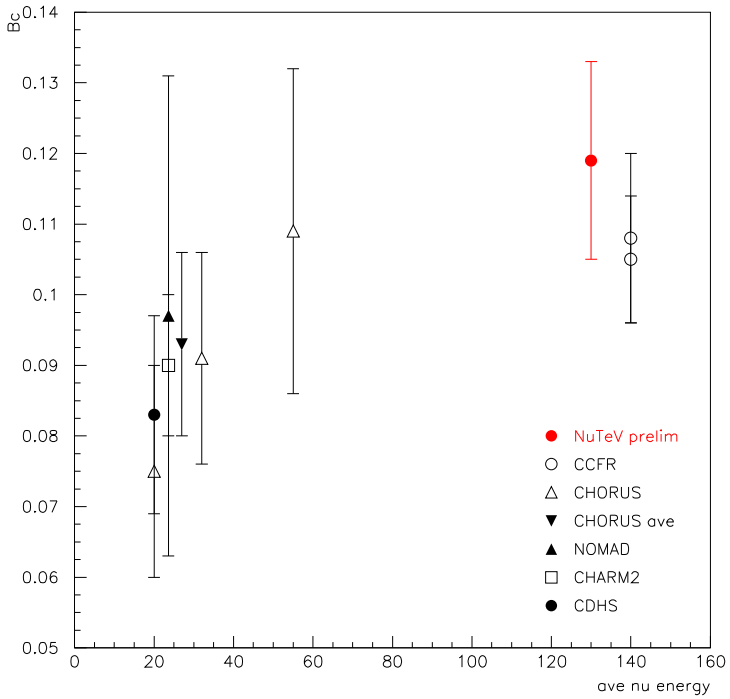
LO S^- comparisons



- Yellow region brings NuTeV $\sin^2\theta_W$ to S.M.
  - Effect on $\sin^2\theta_W$ is x dependent
    asymmetry at high x would need to be larger.
  - Use functional in Zeller et al; Phys.Rev. D65 (2002) 111103
- Red point uses final NuTeV bgpar and flux, which best describes NuTeV data

Branching Ratio

- Desire accurate B_c from external measurements
- B_c is an average semi-μ branching ratio over all charm states
- At LO, we include as parameter in fits
- Half of asymmetry error comes from B_c uncertainty
- In NLO analysis will fix B_c and m_c for highest accuracy in S^- measurement



- In preparation for final dimuon results have re-analyzed data
- Discovered and fixed flaws in past $\mu\mu$ result
- Have new preliminary cross section table
- Presented new preliminary LO strange sea fits
- Will become final with final NLO results later this spring!

The NuTeV Collaboration:

T. Adams[4], A. Alton[4], S. Avvakumov[8], L. de Barbaro[5], P. de Barbaro[8], R. H. Bernstein[3], A. Bodek[8], T. Bolton[4], J. Brau[6], D. Buchholz[5], H. Budd[8], L. Bugel[3], J. Conrad[2], R. B. Drucker[6], B. T. Fleming[2], R. Frey[6], J. A. Formaggio[2], J. Goldman[4], M. Goncharov[4], D. A. Harris[8], R. A. Johnson[1], J. H. Kim[2], S. Koutsoliotas[2], M. J. Lamm[3], W. Marsh[3], D. Mason[6], J. McDonald[7], K. S. McFarland[8,3], C. McNulty[2], D. Naples[7], P. Nienaber[3], V. Radescu[7], A. Romosan[2], W. K. Sakumoto[8], H. Schellmann[5], M. H. Shaevitz[2], P. Spentzouris[2], E. G. Stern[2], N. Suwonjandee[1], M. Tzanov[7], M. Vakili[1], A. Vaitaitis[2], U. K. Yang[8], J. Yu[3], G. P. Zeller[5], and E. D. Zimmerman[2]

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