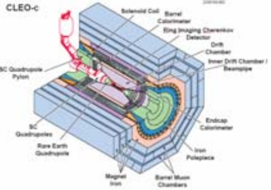


CLEO-c results at the $\Psi(3770)$

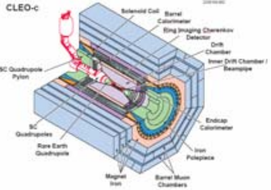
David H. Miller

Purdue University

(Representing the CLEO collaboration)

FPCP, Daegu, South Korea

October 4 – 9 , 2004

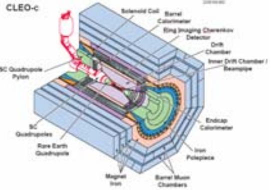


CLEO-c Program

- **3 year program with multi fb^{-1} data sets at the**

  J/ψ $\psi(3770)$ $\psi(4160)$

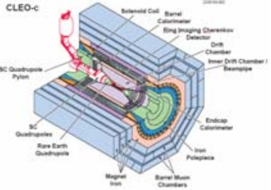
- **Decay constants of the D^+ and D_s**
- **CKM elements V_{cd} and V_{cs} (to 1 – 1.4%)**
- **Form factors**
- **Unitarity tests of CKM matrix**
- **Test Lattice QCD**
- **Improve V_{td} V_{ts} $V_{cb,}$ V_{ub}**
- **Quarkonia transitions and decays**
- **Glue balls, new spectroscopy**



Current status of CLEO-c

The CLEO-c program required the installation of 12 wigglers to the CESR accelerator

- **Phase 1 57.2 pb^{-1} at $\psi(3770)$ with 6 wigglers from Dec 03 to March 04**
- **Final Phase started September 19 with all 12 wigglers running at the $\psi(3770)$ until mid December**
- **Future running about 50% of each year to complete our three year plan**

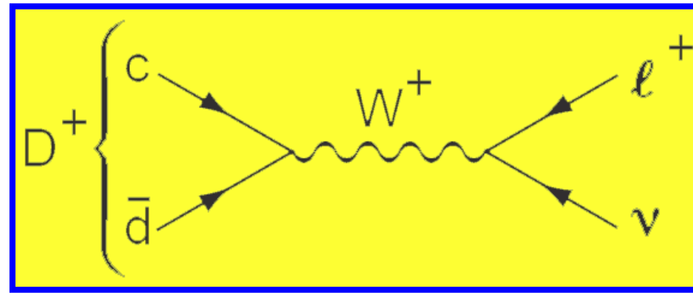


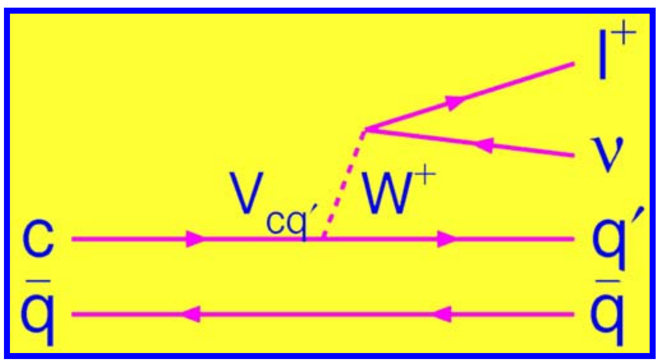
Physics of the $\Psi(3770)$

57.2 pb^{-1} (determined using $\gamma\gamma$ events) E_{cm}=3.77 GeV

All results are preliminary

D^0, D^+ → Hadrons

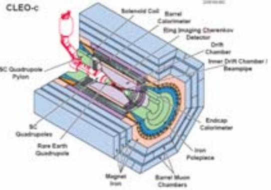




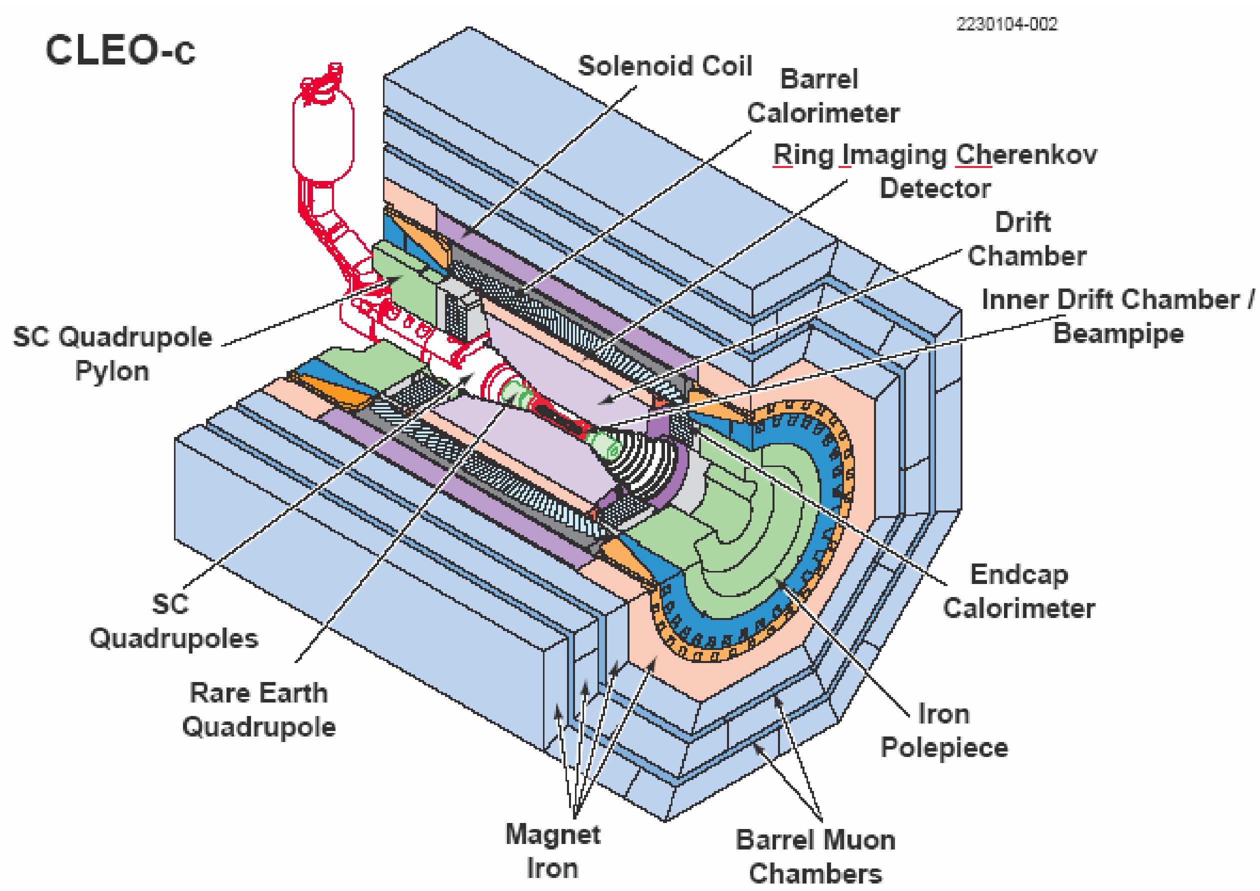
$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

Cleo ICHEP papers http://www.lns.cornell.edu/public/CONF/2004

Review ICHEP http://www.ihep.ac.cn/data/ichep04/ppt/plenary/p16-shipsey-i.pdf



CLEO-c detector



B=1 Tesla

0.6% P = 1GeV/c

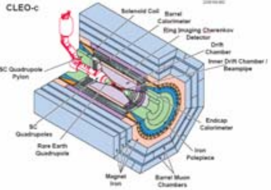
2.2% Eγ = 1 GeV

5% Eγ = 100 MeV

Track 93% of 4π

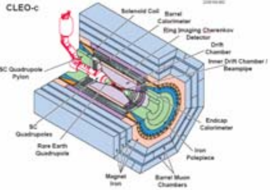
RICH 80% of 4π

Eγ |cosΘ| < .93

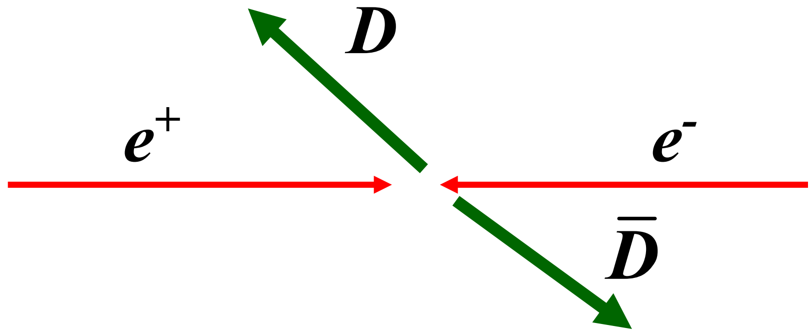


Analysis tools

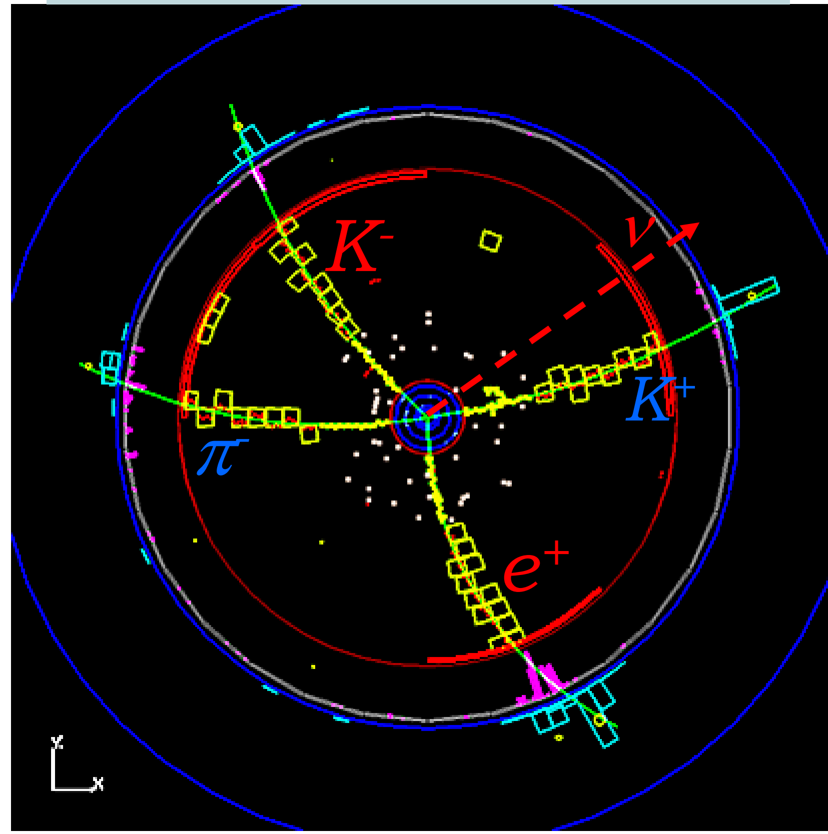
- **Well understood, high resolution, detector with a tuned Monte Carlo**
- **Simple low multiplicity events**
- **dE/dx (π, K, p, e)**
- **RICH detector (K threshold is ~ 550MeV)**
- **dE/dx + RICH > 90% efficiency < 5% fake rate**
- **CsI calorimeter (e, μ)**
- **Hermeticity of the detector (neutrinos)**
- **Beam energy $\sigma_{Ecm} = 2.3$ MeV**



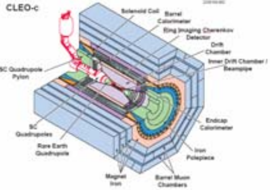
$\Psi(3770)$ analysis techniques



Semileptonic decay (data)



The analysis technique common to all the *D* physics is to fully reconstruct one *D* (or $\bar{D}$) and then analyze the decay of the other $\bar{D}$ (or *D*) to extract the properties of exclusive and inclusive decays



CLEO-c Tagged *D* samples

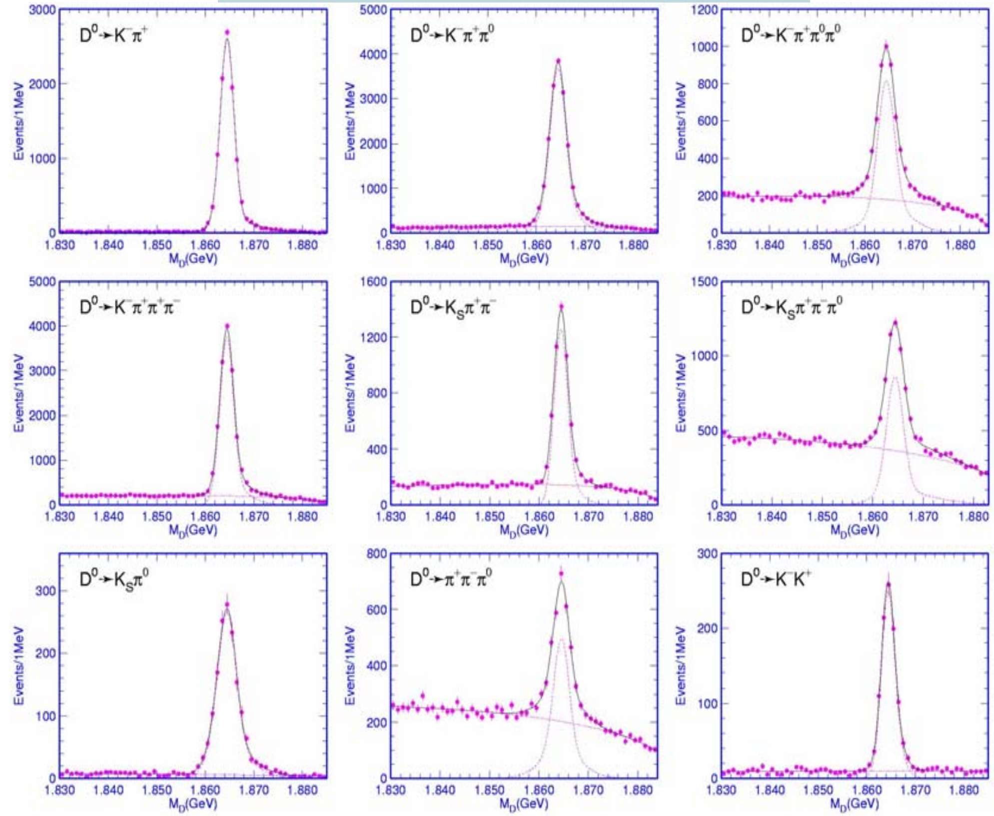
We use the variables

$$M_{BC} = \sqrt{E_{\text{beam}}^2 - \left|p\left(D\right)\right|^2}$$

$$\Delta E = E\left(D\right) - E_{\text{beam}}$$

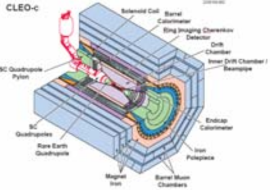
Each analysis uses slightly differing tagged samples since the analyses are works in progress.

Tagged D^0 decays



$|\Delta E| < 20 \rightarrow 35$ MeV

Multiple candidates choose smallest ΔE



D hadronic branching ratios

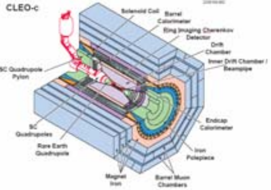
We use a double tag technique first used by Mark III to measure branching ratios and this does not require knowing the luminosity

$$N_i = 2\varepsilon_i B_i N_{D\bar{D}}$$

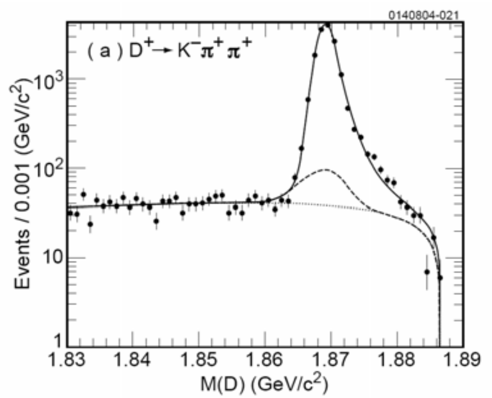
$$N_{ii} = \varepsilon_{ii} B_i^2 N_{D\bar{D}}$$

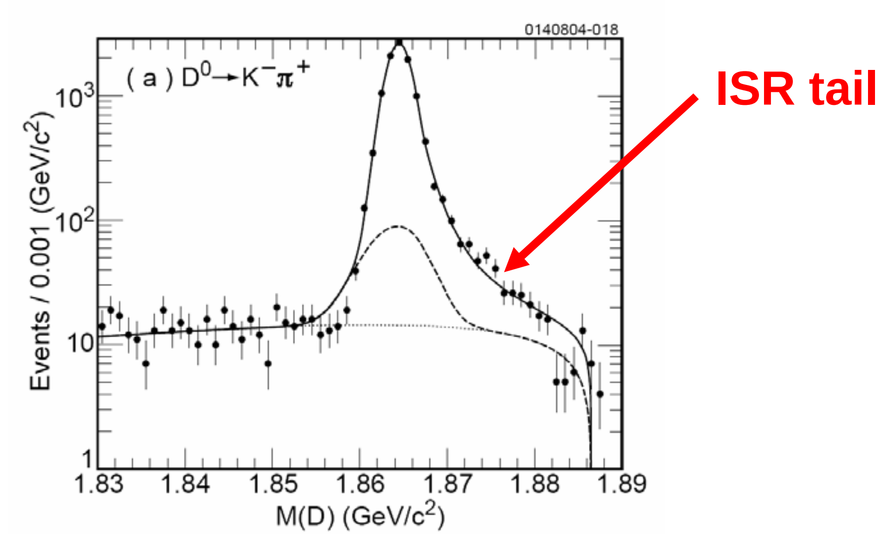
$$N_{D\bar{D}} = \frac{N_i^2 \quad \varepsilon_{ii}}{4N_{ii} \quad \varepsilon_i^2}$$

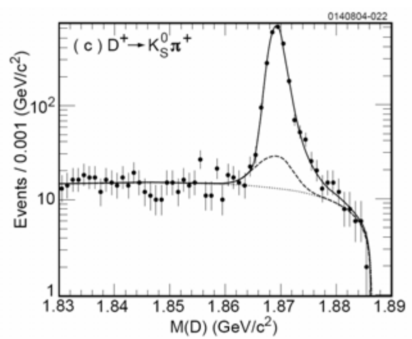
Use 3 D^0 modes ($K^-\pi^+$, $K^-\pi^+\pi^0$, $K^-\pi^+\pi^-\pi^+$)
And 2 D^+ modes ($K^-\pi^+\pi^+$, $K_s\pi^+$)
This gives 10 single tag modes and 13 double tag

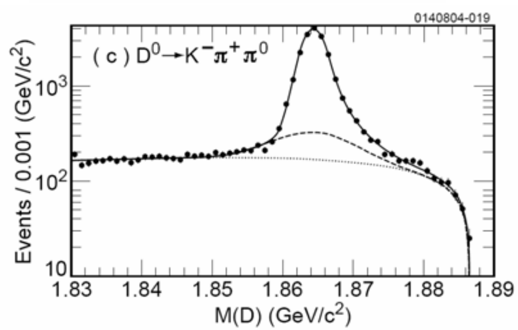


D^0 and D^+ single tags







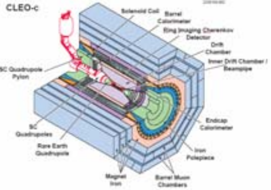


Binned likelihood fits to extract N_i:

» **An inverted Crystal Ball function accounting for core Gaussian with ISR tail.**

» **A bifurcated Gaussian modeling signal and tails due to misreconstruction**

» **An ARGUS function representing backgrounds.**

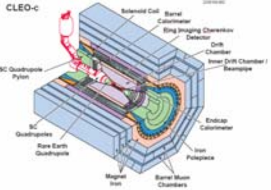


Yields (Preliminary)

D or $\bar{D}$ Mode	Yield (10^3)	Efficiency (%)
$D^0 \to K^-\pi^+$	5.14 ± 0.07	65.1 ± 0.6
$\bar{D}^0 \to K^+\pi^-$	5.16 ± 0.08	66.3 ± 0.6
$D^0 \to K^-\pi^+\pi^0$	9.62 ± 0.12	33.6 ± 0.4
$\bar{D}^0 \to K^+\pi^-\pi^0$	9.58 ± 0.12	34.0 ± 0.4
$D^0 \to K^-\pi^+\pi^+\pi^-$	7.39 ± 0.10	45.1 ± 0.5
$\bar{D}^0 \to K^+\pi^-\pi^-\pi^+$	7.39 ± 0.10	45.5 ± 0.5
$D^+ \to K^-\pi^+\pi^+$	7.58 ± 0.09	52.2 ± 0.5
$D^- \to K^+\pi^-\pi^-$	7.57 ± 0.09	51.9 ± 0.5
$D^+ \to K^0_S\pi^+$	1.09 ± 0.04	45.6 ± 0.5
$D^- \to K^0_S\pi^-$	1.12 ± 0.04	45.9 ± 0.5

TOTAL single tags

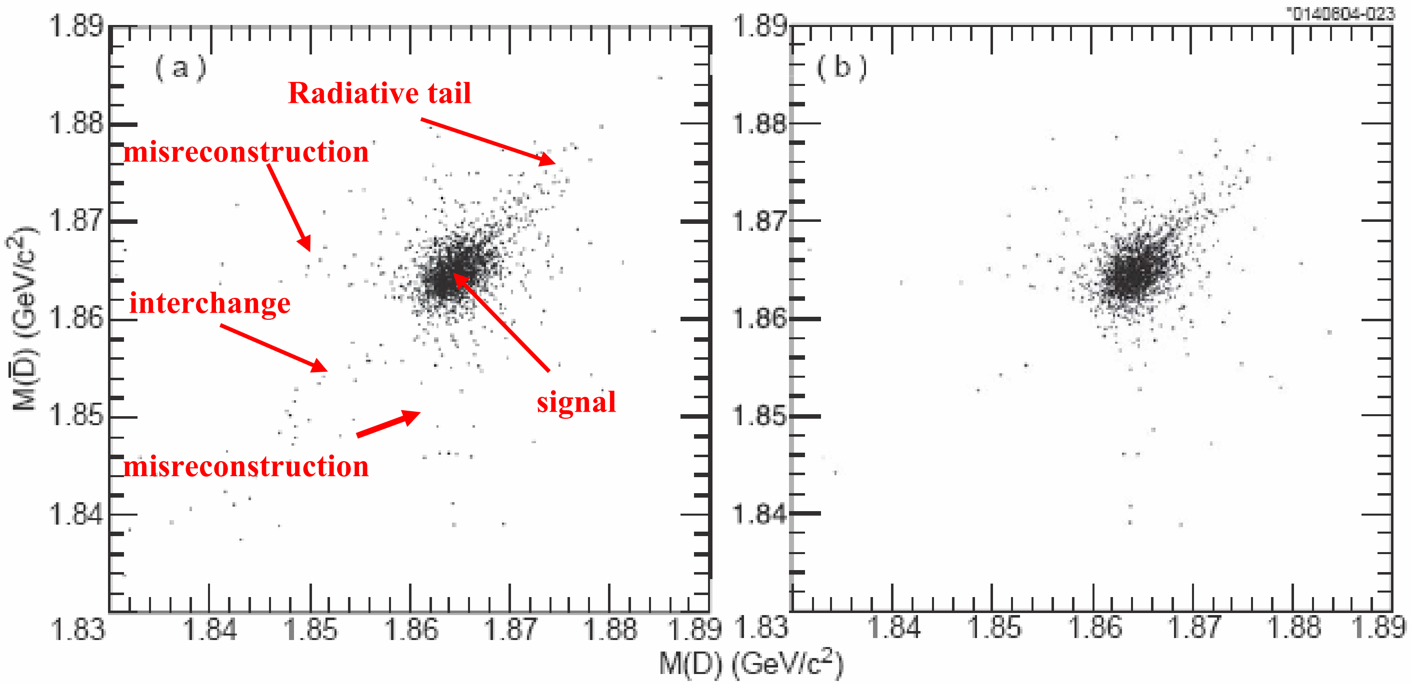
D^0 ~ 44,000
D^+ ~ 17,000



Double tag (Monte Carlo)

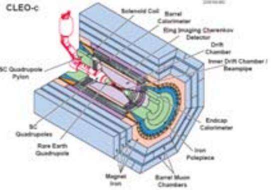
$D^0 \rightarrow K^-\pi^+\pi^0$ $\quad$ $\overline{D^0} \rightarrow K^+\pi^-\pi^0$

All candidates $\quad$ "Best combination"



Best combination choose $\hat{M}_{BC} \equiv \dfrac{M_{BC}^{D} + M_{BC}^{\bar{D}}}{2}$ **nearest to** M_{D^0} **or** M_{D^+} **.**

Monte Carlo studies show no peaking background.

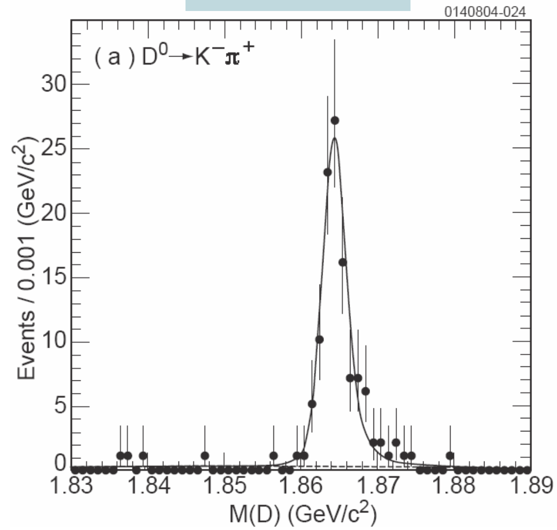


Double tag yields D^0

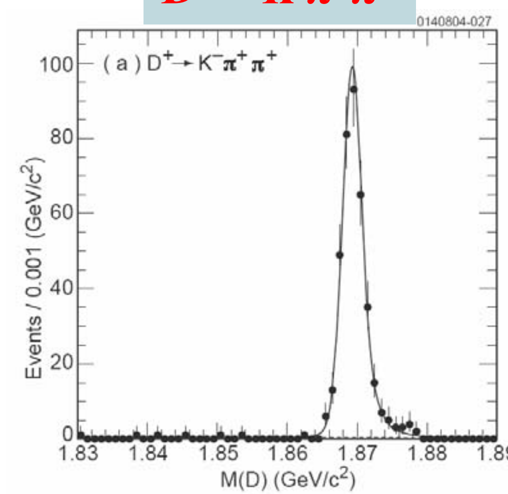
D Mode	$\bar{D}$ Mode	Yield (10^2)	Efficiency (%)
$D^0 \to K^-\pi^+$	$\bar{D}^0 \to K^+\pi^-$	1.09 ± 0.11	42.6 ± 0.5
$D^0 \to K^-\pi^+\pi^0$	$\bar{D}^0 \to K^+\pi^-\pi^0$	4.84 ± 0.23	12.1 ± 0.3
$D^0 \to K^-\pi^+\pi^+\pi^-$	$\bar{D}^0 \to K^+\pi^-\pi^-\pi^+$	2.80 ± 0.17	20.8 ± 0.4
$D^0 \to K^-\pi^+$	$\bar{D}^0 \to K^+\pi^-\pi^0$	2.45 ± 0.16	23.2 ± 0.4
$D^0 \to K^-\pi^+\pi^0$	$\bar{D}^0 \to K^+\pi^-$	2.62 ± 0.16	22.6 ± 0.4
$D^0 \to K^-\pi^+$	$\bar{D}^0 \to K^+\pi^-\pi^-\pi^+$	2.05 ± 0.14	29.6 ± 0.4
$D^0 \to K^-\pi^+\pi^+\pi^-$	$\bar{D}^0 \to K^+\pi^-$	1.97 ± 0.14	29.6 ± 0.4
$D^0 \to K^-\pi^+\pi^0$	$\bar{D}^0 \to K^+\pi^-\pi^-\pi^+$	3.59 ± 0.20	15.2 ± 0.3
$D^0 \to K^-\pi^+\pi^+\pi^-$	$\bar{D}^0 \to K^+\pi^-\pi^0$	3.40 ± 0.19	15.5 ± 0.3
$D^+ \to K^-\pi^+\pi^+$	$D^- \to K^+\pi^-\pi^-$	3.79 ± 0.20	26.7 ± 0.4
$D^+ \to K^0_S\pi^+$	$D^- \to K^0_S\pi^-$	0.090 ± 0.030	20.6 ± 0.4
$D^+ \to K^-\pi^+\pi^+$	$D^- \to K^0_S\pi^-$	0.609 ± 0.079	23.7 ± 0.4
$D^+ \to K^0_S\pi^+$	$D^- \to K^+\pi^-\pi^-$	0.530 ± 0.073	23.9 ± 0.4

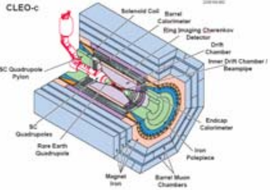
Double Tags ~ 3000

$D^0 \to K^-\pi^+$



$D^+ \to K^-\pi^+\pi^+$



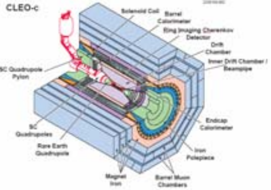


Binned 2-D likelihood fit to extract *Nij*:

The fit for a double tag yield is a 2-*D* fit using 5 functions and includes correlations due to beam energy fluctuations and ISR.

In a combined χ^2 fit using all 10 single tags and 13 double tags we extract 5 branching ratios and the $D\bar{D}$ yields.

This fit includes systematic errors.



Branching ratios

Parameter	Fitted Value
$N_{D^0\bar{D}^0}$	$(1.98 \pm 0.04 \pm 0.03) \times 10^5$
$\mathcal{B}(D^0 \to K^-\pi^+)$	$0.0392 \pm 0.0008 \pm 0.0023$
$\mathcal{B}(D^0 \to K^-\pi^+\pi^0)$	$0.143 \pm 0.003 \pm 0.010$
$\mathcal{B}(D^0 \to K^-\pi^+\pi^+\pi^-)$	$0.081 \pm 0.002 \pm 0.009$
$N_{D^+D^-}$	$(1.48 \pm 0.06 \pm 0.04) \times 10^5$
$\mathcal{B}(D^+ \to K^-\pi^+\pi^+)$	$0.098 \pm 0.004 \pm 0.008$
$\mathcal{B}(D^+ \to K^0_S\pi^+)$	$0.0161 \pm 0.0008 \pm 0.0015$
$\mathcal{B}(D^0 \to K^-\pi^+\pi^0)/\mathcal{B}(D^0 \to K^-\pi^+)$	$3.64 \pm 0.05 \pm 0.17$
$\mathcal{B}(D^0 \to K^-\pi^+\pi^+\pi^-)/\mathcal{B}(D^0 \to K^-\pi^+)$	$2.05 \pm 0.03 \pm 0.14$
$\mathcal{B}(D^+ \to K^0_S\pi^+)/\mathcal{B}(D^+ \to K^-\pi^+\pi^+)$	$0.164 \pm 0.004 \pm 0.006$

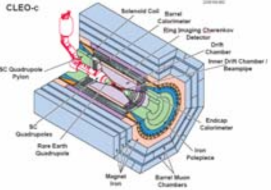
FSR is included in MC efficiencies (using PHOTOS) this increases branching ratios by 0.5→2%

Future goal

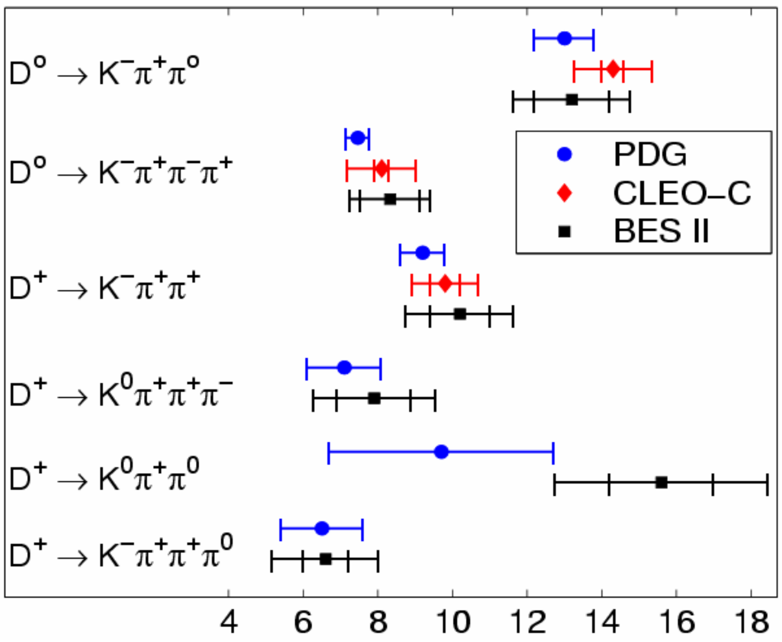
D^0 to $K\pi$

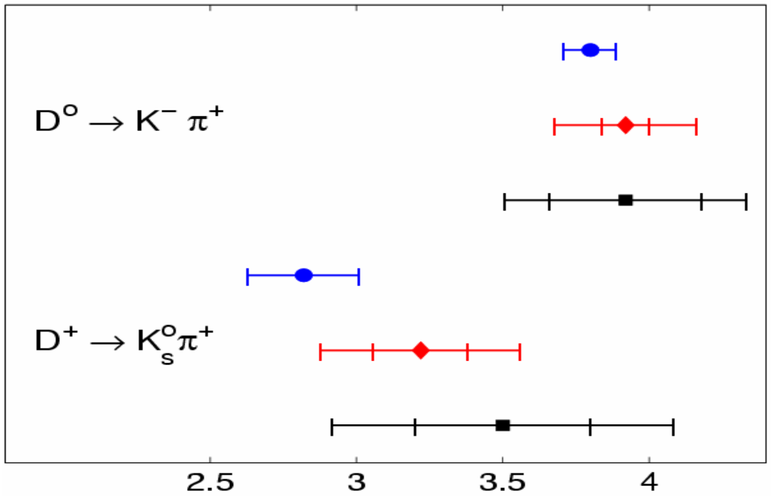
D^+ to $K\pi\pi$ 1 – 2%

D_s to $\varphi\pi$



CLEO-c and Bes II results





ICHEP Ian Shipsey

BES

$$\sigma^{obs}_{D^0\bar{D}^0} = 3.58 \pm 0.09 \pm 0.31 nb$$

$$\sigma^{obs}_{D^+D^-} = 2.56 \pm 0.08 \pm 0.26 nb$$

$$\sigma^{obs}_{DD} = 6.14 \pm 0.12 \pm 0.50 nb$$

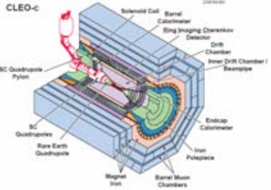
CLEO-c

$$\sigma\left(D^0\bar{D}^0\right) = \left(3.47 \pm 0.07 \pm 0.15\right) nb$$

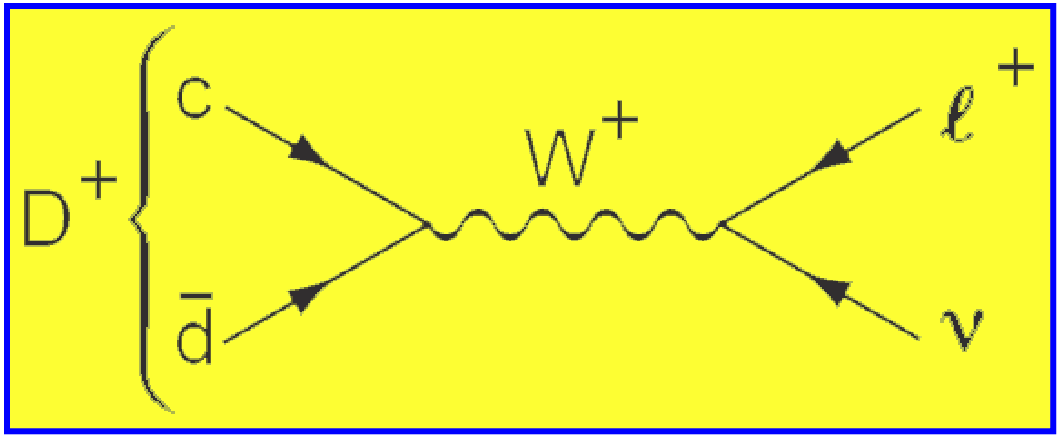
$$\sigma\left(D^+D^-\right) = \left(2.59 \pm 0.11 \pm 0.11\right) nb$$

$$\sigma\left(DD\right) = \left(6.06 \pm 0.13 \pm 0.23\right) nb$$

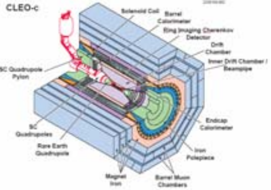
$\sigma(DD) = (5.0 \pm 0.5)$nb (Mark III)



$D^+ \rightarrow \mu^+ \nu$



$$\Gamma\left(D^+ \rightarrow l^+ \nu\right) = \frac{G_F^2}{8\pi} f_{D^+}^2 m_l^2 M_{D^+} \left(1 - \frac{m_l^2}{M_{D^+}^2}\right)^2 \left|V_{cd}\right|^2$$

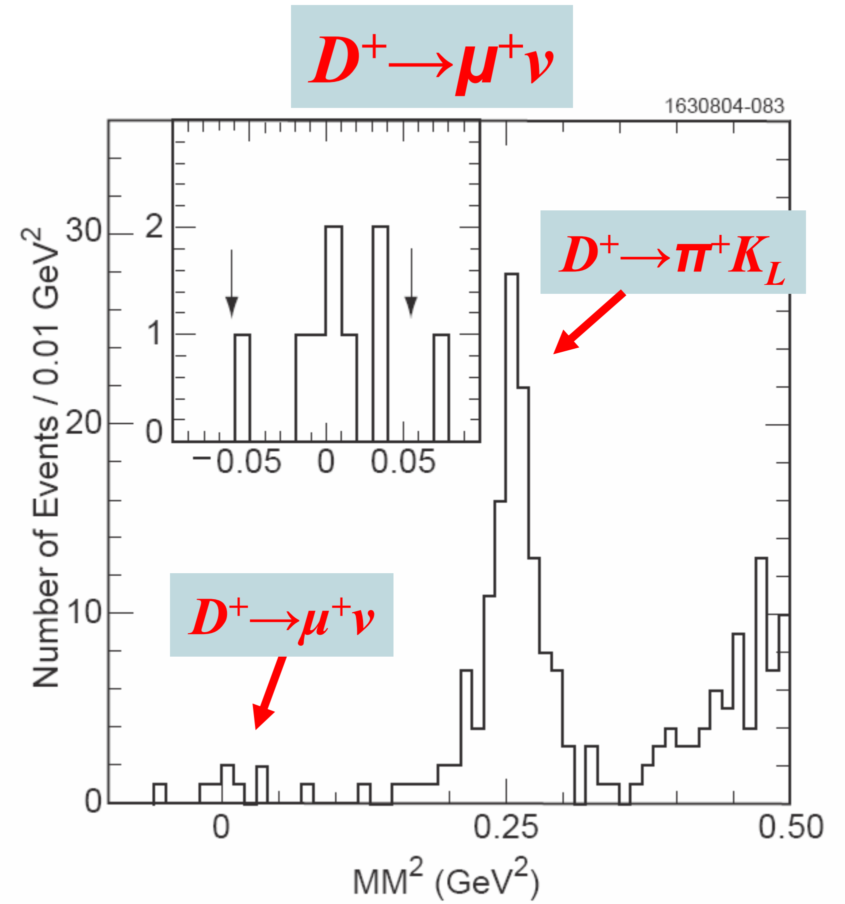


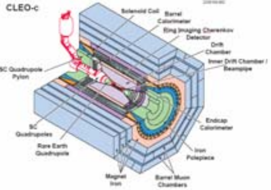
Signal for $D^+ \to \mu^+ \nu$

- For events with μ candidate form

$$MM^2 = \left(E_{beam} - E_\mu\right)^2 - \left(-p_{D^-} - p_\mu\right)^2$$

- Signal will peak at $MM^2 = m^2_\nu = 0$
- Muons are required to deposit less than 300 MeV in the calorimeter
- No additional tracks from IP
- Largest unmatched shower to be less than 250 MeV, to veto





Decay constant and Branching ratio

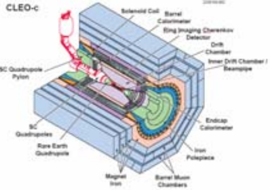
- **8 signal candidate events with the following backgrounds**

Background	$\mathcal{B}$ (%)	# of events
$D^+ \to \pi^+\pi^0$	0.13 ± 0.02	0.31 ± 0.04
$D^+ \to K^0\pi^+$	2.77 ± 0.18	0.06 ± 0.05
$D^+ \to \tau^+\nu$	$3.2 \times \mathcal{B}(D^+ \to \mu^+\nu)$	0.36 ± 0.08
$D^+ \to \pi^0\mu^+\nu$	0.31 ± 0.15	negligible
$D^0\bar{D}^0$	—	0.16 ± 0.16
continuum	—	0.17 ± 0.17
Total		1.07 ± 0.25

- **Due to simulation uncertainties the background is 1.07 ± 1.07**
- **With 28575 D^+ tags and an efficiency of 69.9% for signal events to satisfy the selection criteria given a D^+ tag we obtain:**

$$Bf = \left(D^+ \to \mu^+\nu\right) = \left(3.5 \pm 1.4 \pm 0.6\right) \times 10^{-4} \qquad f_{D^+} = \left(201 \pm 41 \pm 17\right)\text{MeV}$$

- **Theoretical predictions for f_D are in the range 190 to 260 MeV.**



Summary of $D^+ \rightarrow \mu^+ \nu$

CLEO-c

Tags 28575

Signal 8

Bkgd 1.07 ± 1.07

$B = (3.5 \pm 1.4 \pm 0.6) \times 10^{-4}$

$f_{D+} = (201 \pm 41 \pm 17) MeV$

BESII

5400

3

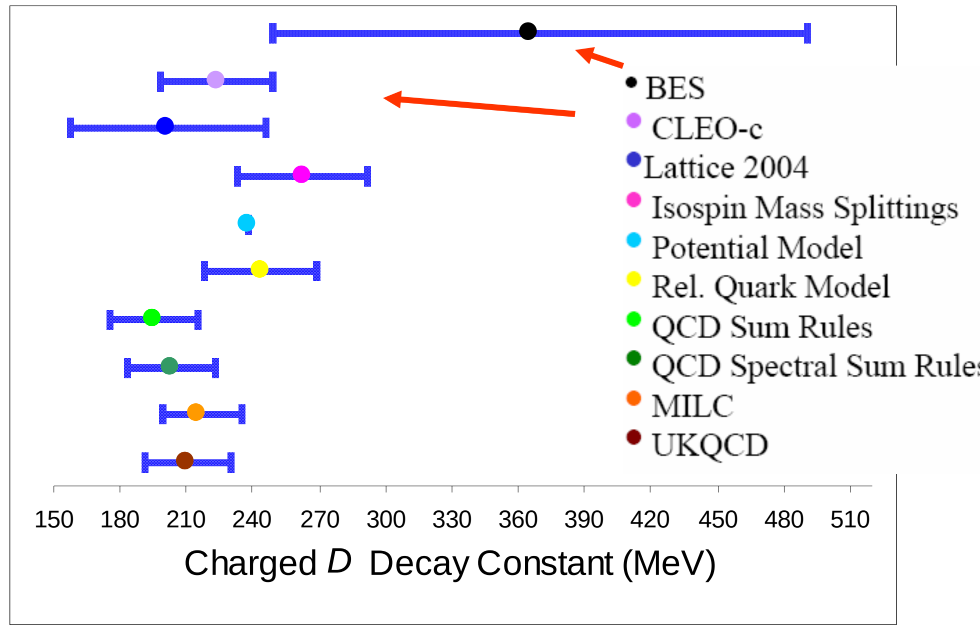
0.25

$B = (0.12 {}^{+0.092}_{-0,063} {}^{+0.01}_{-0.009})\%$

$f_{D+} = (365 {}^{+121}_{-113} {}^{+32}_{-28})$ MeV

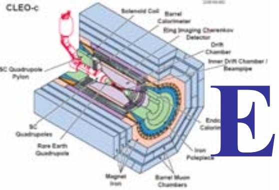
Mark III <290 MeV

BES I: 1 event (1998)



ICHEP Ian Shipsey

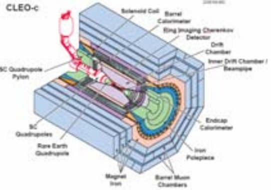
Future goal f_{D^+} to 2.3%, f_{D_s} to 1.9%



Exclusive D^0 semileptonic decays

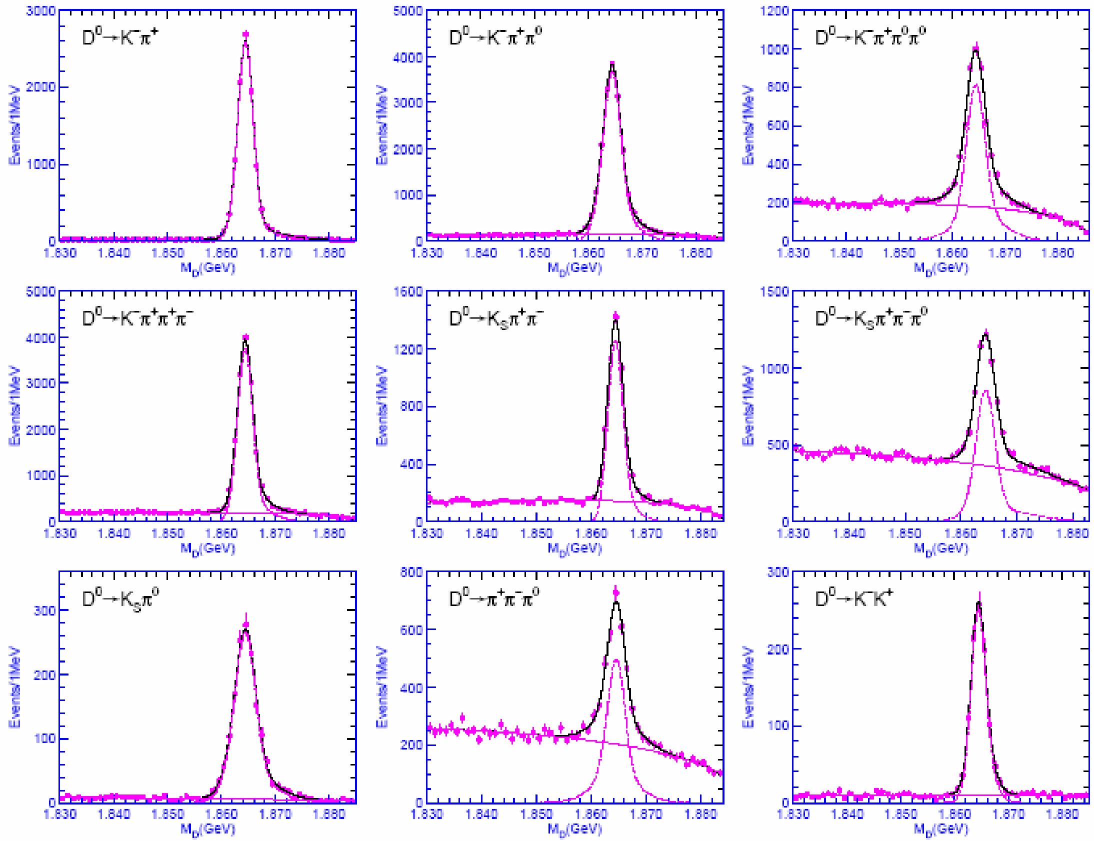
We have just begun the detailed analysis of semileptonic decays which are one of the most important thrusts of the CLEO-c Program. We will analyze D^0, D^+, D_s decays and measure

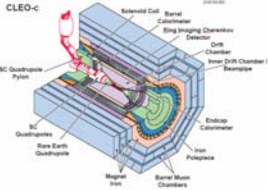
- **branching ratios**
- **q^2 distributions and form factors**
- **spectral moments**



CLEO-c *D* Tag samples

Semileptonic decays using *D* tags





Monte Carlo $D^0 \rightarrow K^- e^+ \nu$ and $\pi^- e^+ \nu$

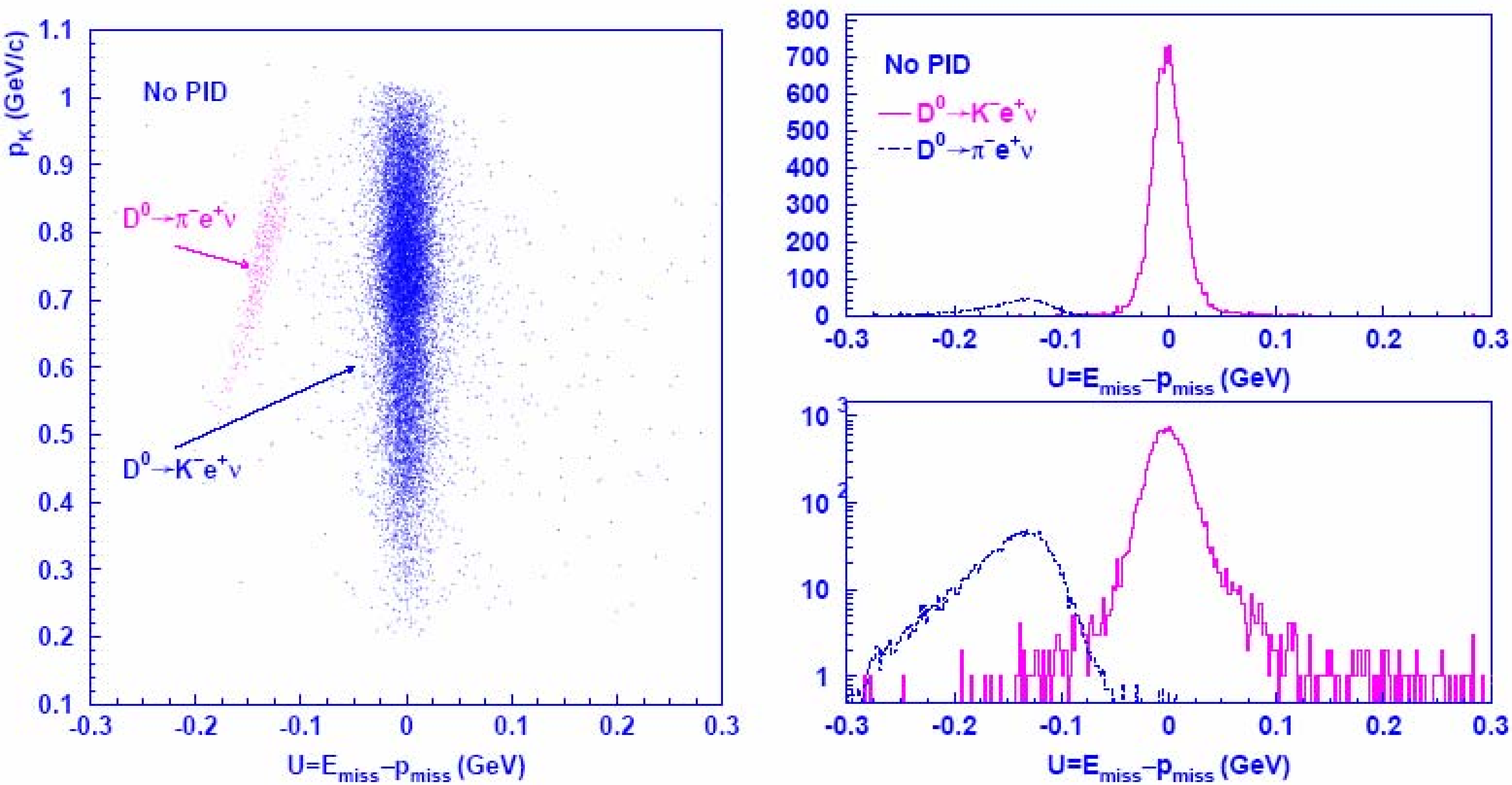
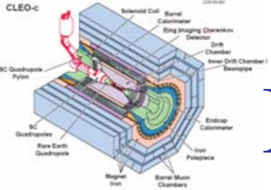


FIG. 3: Kaon momentum vs. $U = E_{\rm miss} - p_{\rm miss}$ from $D^0 \rightarrow K^- e^+ \nu$ signal MC. The background from $D^0 \rightarrow \pi^- e^+ \nu$ reconstructed as $D^0 \rightarrow K^- e^+ \nu$ is overlaid and normalized by $\frac{\mathcal{B}(D^0 \rightarrow \pi^- e^+ \nu)}{\mathcal{B}(D^0 \rightarrow K^- e^+ \nu)} = 0.1$ from PDG [6]. The right plot shows the projection onto the U axis in linear and log scales.



Monte Carlo $D^0 \rightarrow K^- e^+ \nu$ and $\pi^- e^+ \nu$

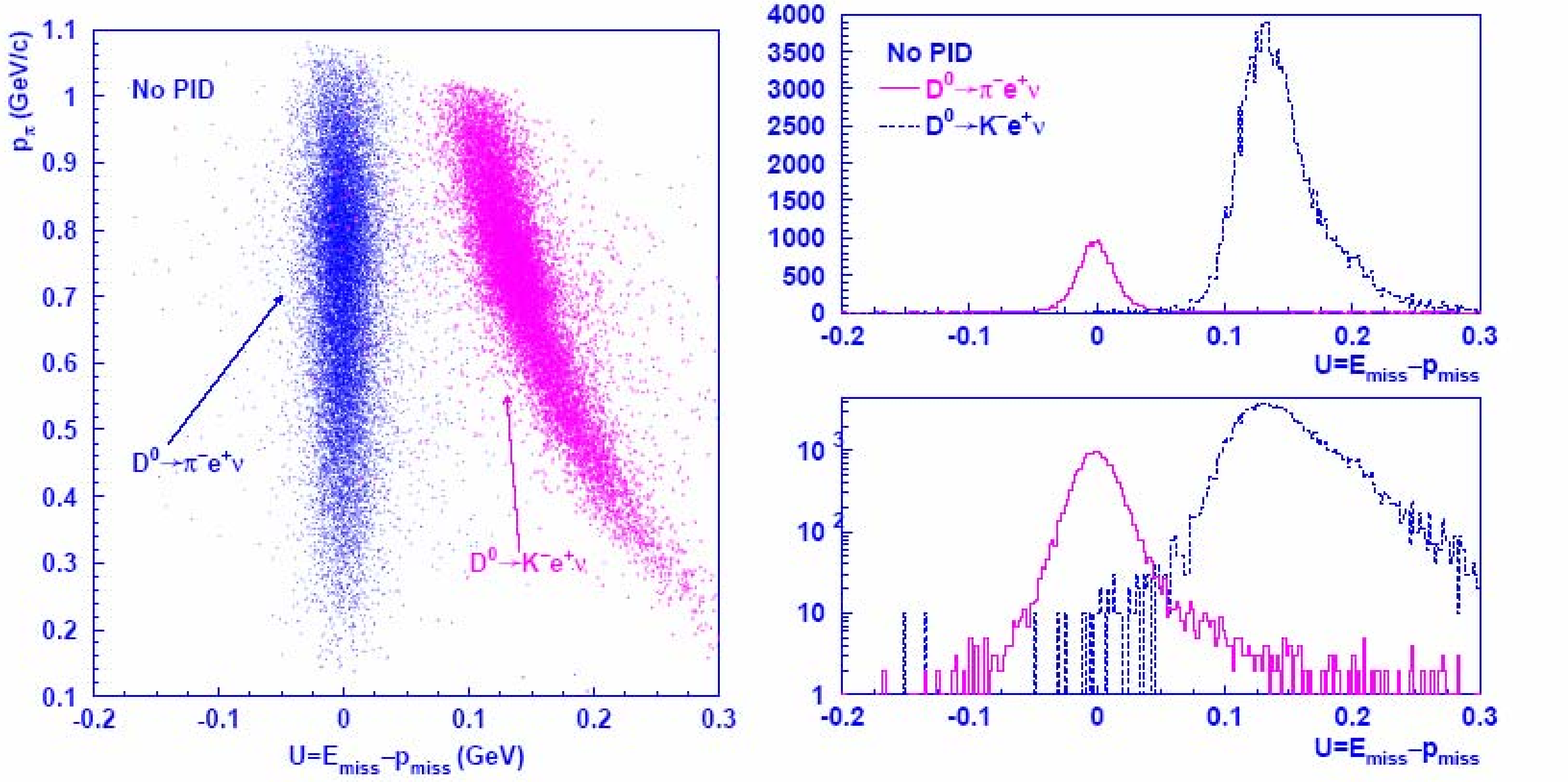
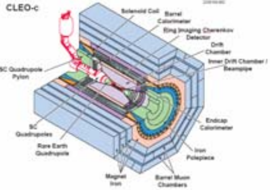
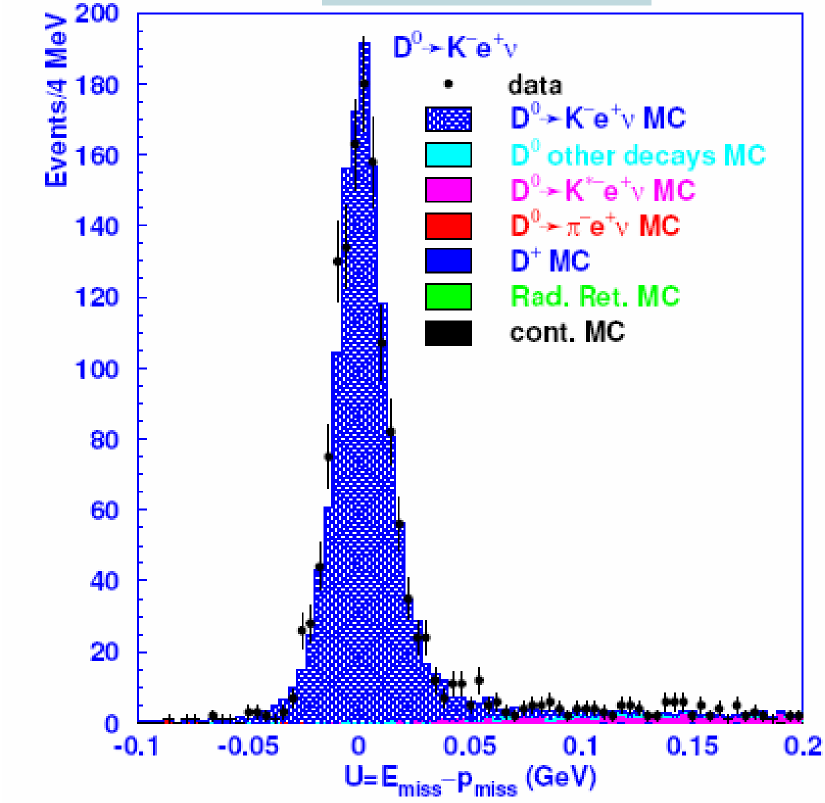


FIG. 4: Pion momentum vs. $U = E_{miss} - p_{miss}$ from $D^0 \rightarrow \pi^- e^+ \nu$ signal MC. The background from $D^0 \rightarrow K^- e^+ \nu$ reconstructed as $D^0 \rightarrow \pi^- e^+ \nu$ is overlaid and normalized by $\frac{\mathcal{B}(D^0 \rightarrow \pi^- e^+ \nu)}{\mathcal{B}(D^0 \rightarrow K^- e^+ \nu)} = 0.1$ from PDG [6]. The right plot shows the projection onto the U axis in linear and log scales.

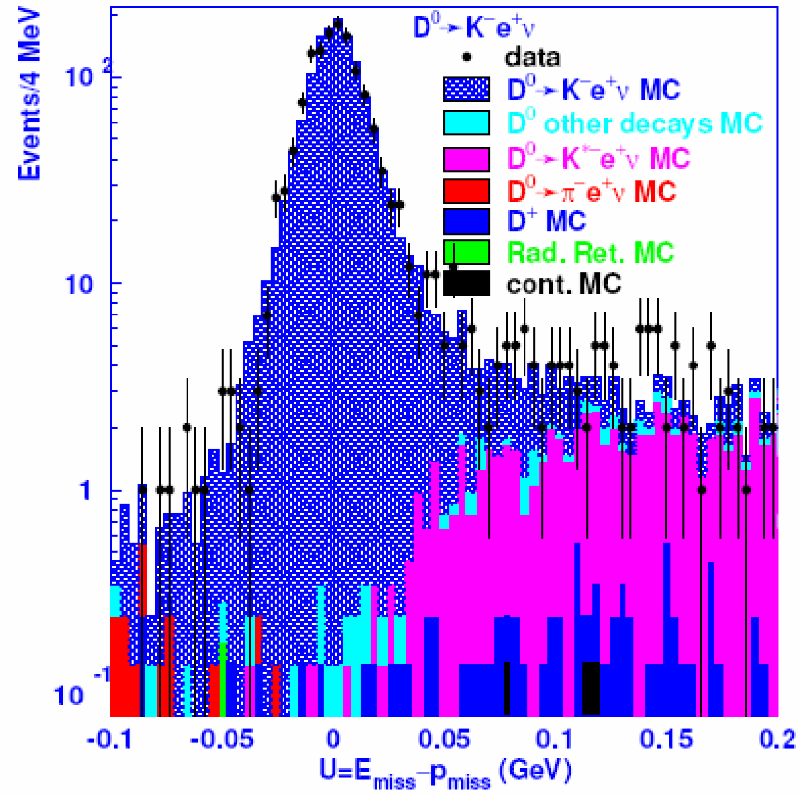


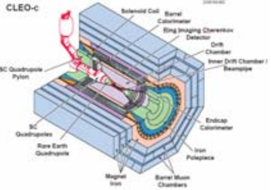
$D^0 \to K^- e^+ \nu$

$D^0 \to K^- e^+ \nu$



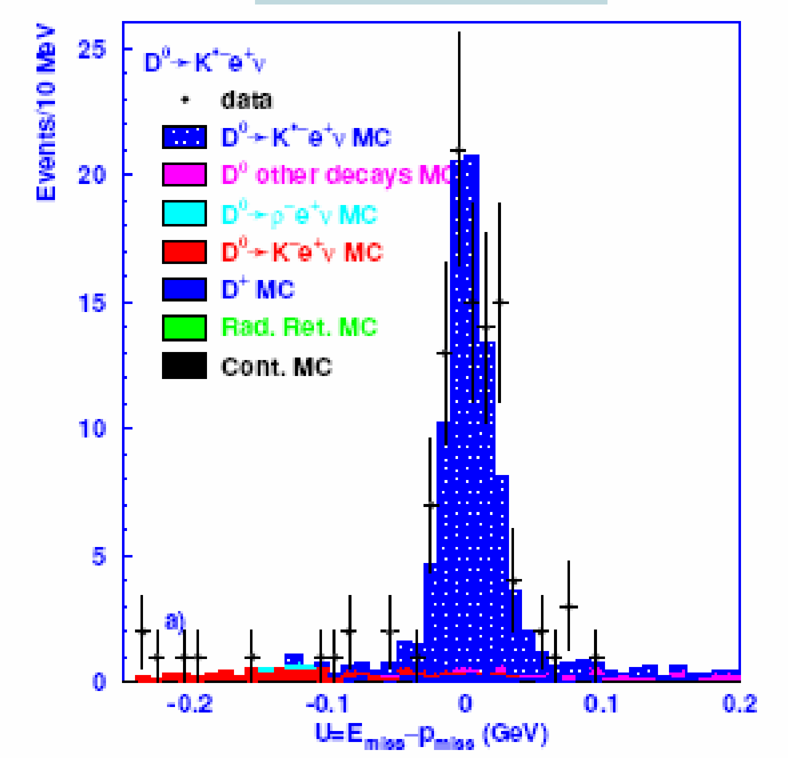
$D^0 \to K^- e^+ \nu$

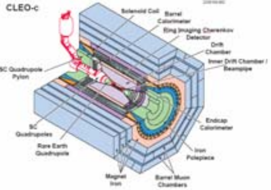




$K^{*-}e^{+}\nu$

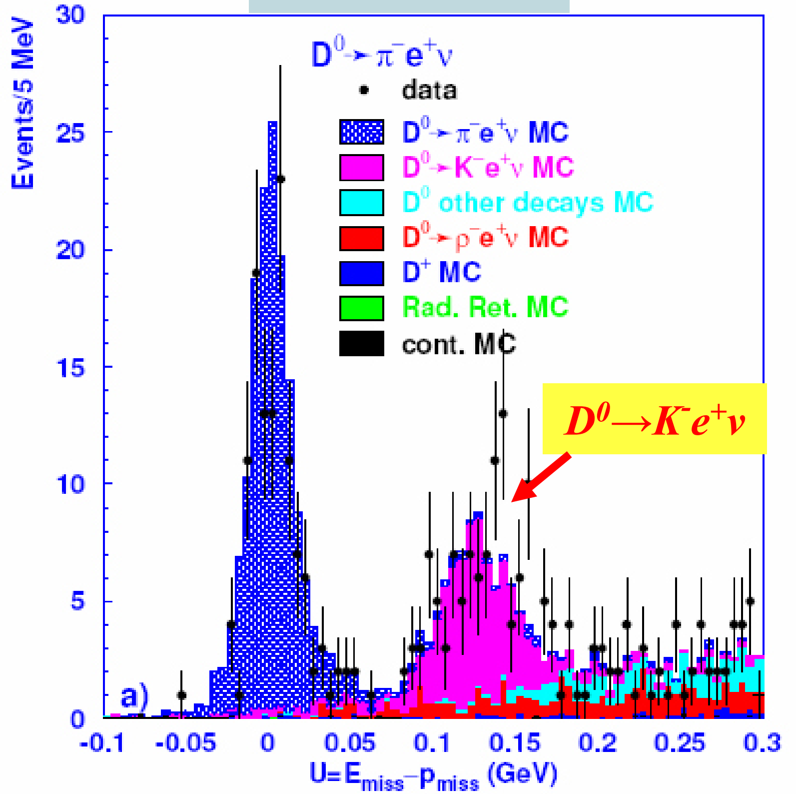
$D^0 \rightarrow K^{*-} e^{+} \nu$



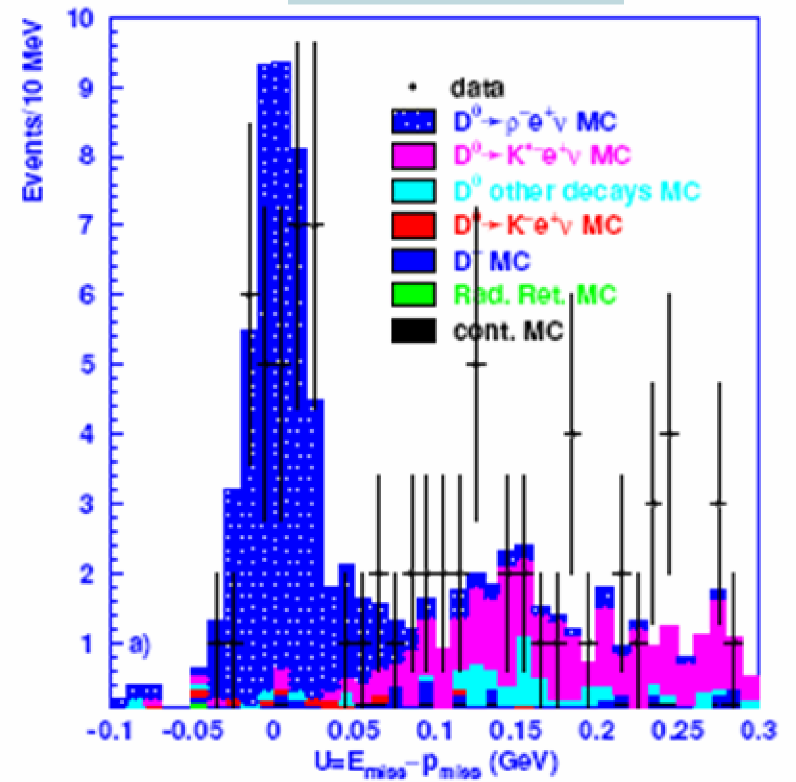


$\pi^- e^+ \nu$ and $\rho^- e^+ \nu$

$D^0 \to \pi^- e^+ \nu$

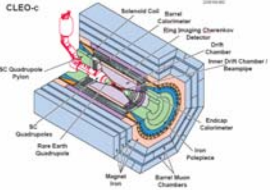


$D^0 \to \rho^- e^+ \nu$



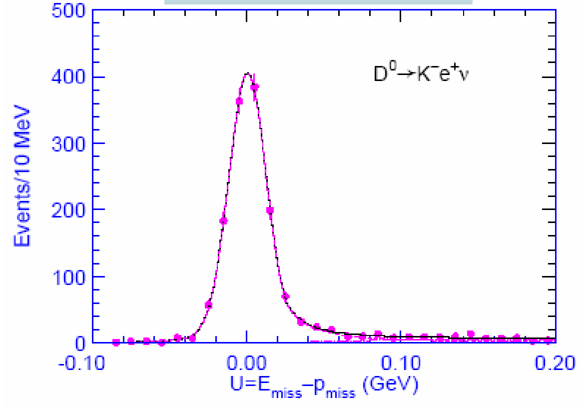
- $N = 109.1 \pm 10.9$

First Observation

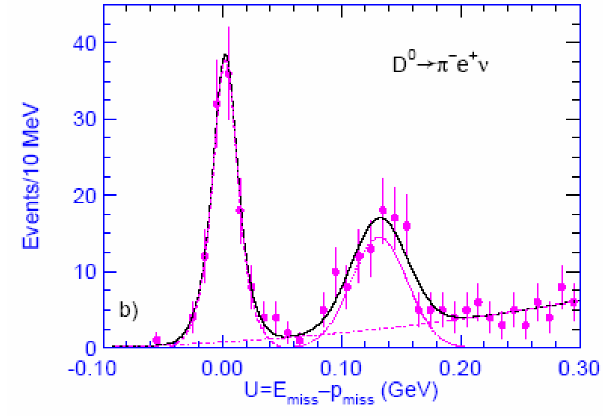


Final Fits

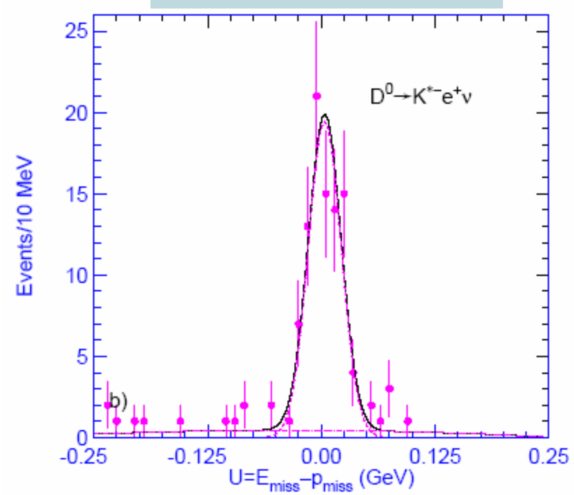
$D^0 \to K^- e^+ \nu$



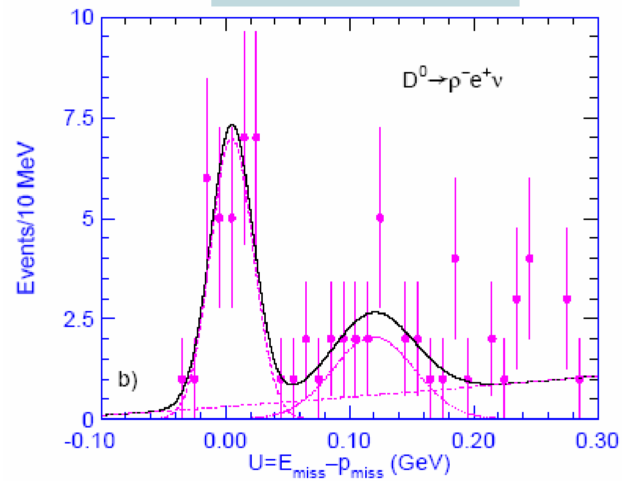
$D^0 \to \pi^- e^+ \nu$

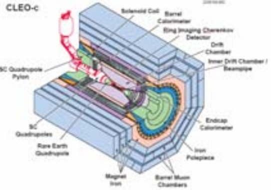


$D^0 \to K^{*-} e^+ \nu$



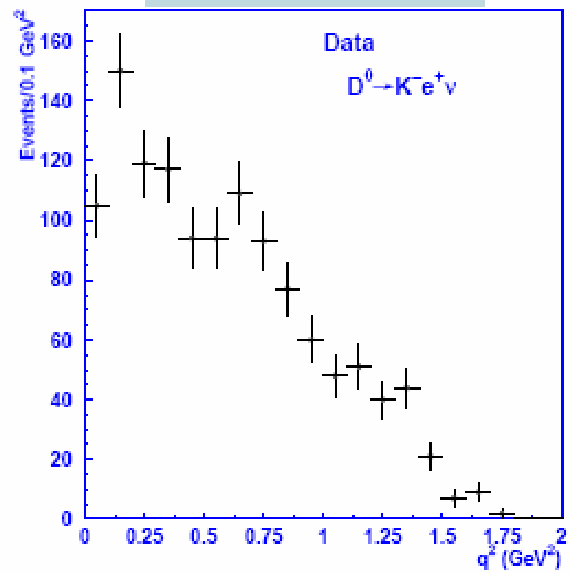
$D^0 \to \rho^- e^+ \nu$



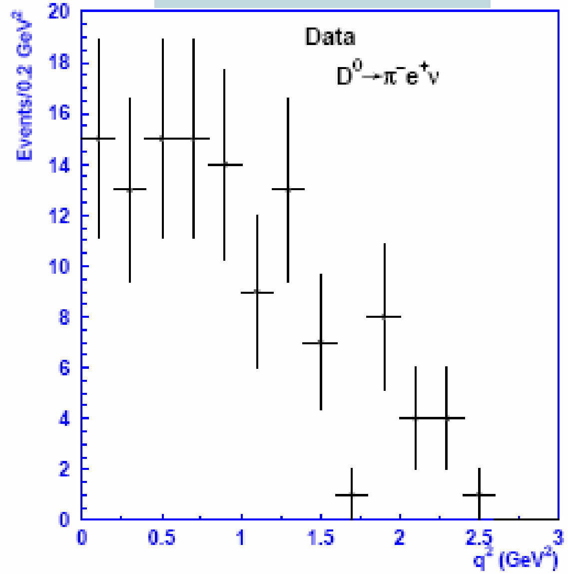


q^2 distributions

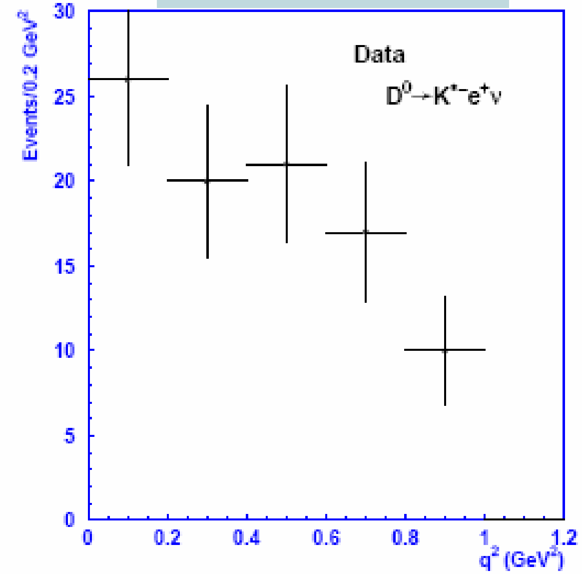
$D^0 \to K^- e^+ \nu$



$D^0 \to \pi^- e^+ \nu$

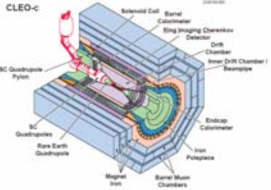


$D^0 \to K^{*-} e^+ \nu$



No efficiency corrections, resolution ~ 0.025 GeV^2

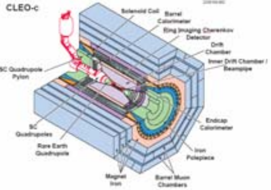
Future goal: slopes ~ 4%, form factors over all q^2



Systematic errors

sources	$D^0 \to K^- e^+ \nu$	$D^0 \to \pi^- e^+ \nu$	$D^0 \to K^{*-} e^+ \nu$	$D^0 \to \rho^- e^+ \nu$
tracking	6	6	6	6
π^0 finding	-	-	4.4	4.4
EID	2	2	2	2
PID	1	1	1	1
extra track	0.5	0.5	0.5	0.5
MC statistics	<1	1.1	2.2	1.9
backgrounds	1.1	3.1	2.9	5.3
ISR	1	1	1	1
Form factors	< 2	< 2	< 2	5.0
Yields	1	1.9	1	2.7
Total	7.0	7.8	8.9	11.2

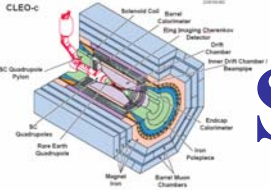
Expect to reduce tracking error to < 1%



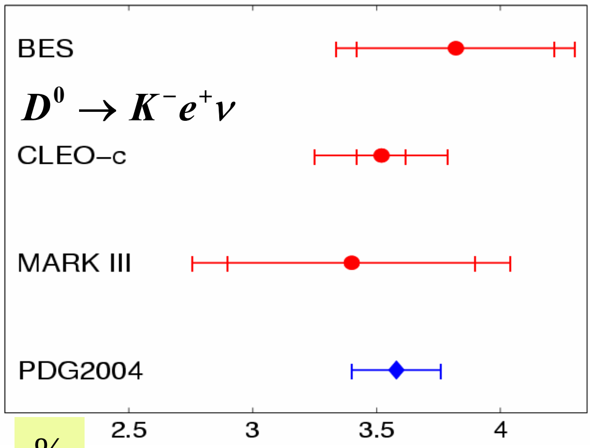
Branching ratios

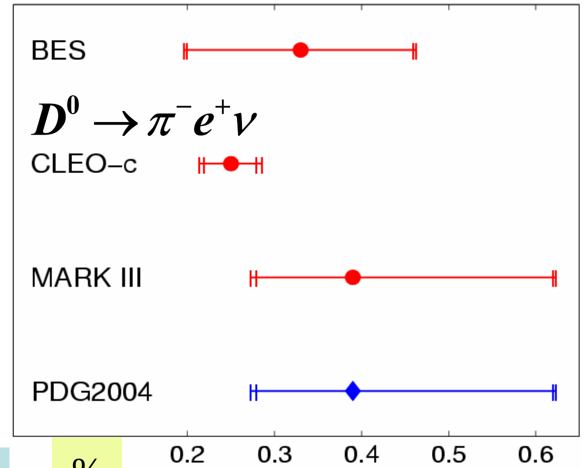
Decays	$\mathcal{B}$	PDG
$D^0 \to K^- e^+ \nu$	$(3.52 \pm 0.10 \pm 0.25)\%$	$(3.58 \pm 0.18)\%$
$D^0 \to \pi^- e^+ \nu$	$(0.25 \pm 0.03 \pm 0.02)\%$	$(0.36 \pm 0.06)\%$
$D^0 \to K^{*-} e^+ \nu$	$(2.07 \pm 0.23 \pm 0.18)\%$	$(2.15 \pm 0.35)\%$
$D^0 \to \rho^- e^+ \nu$	$(0.19 \pm 0.04 \pm 0.02)\%$	none
$\frac{\mathcal{B}(D^0 \to \pi^- e^+ \nu)}{\mathcal{B}(D^0 \to K^- e^+ \nu)}$	$(7.0 \pm 0.7 \pm 0.3)\%$	$(10.1 \pm 1.8)\%$
$\frac{\mathcal{B}(D^0 \to \rho^- e^+ \nu)}{\mathcal{B}(D^0 \to K^{*-} e^+ \nu)}$	$(9.2 \pm 2.0 \pm 0.8)\%$	none

Future goal : D to πlν, Klν ~ 1 – 2%



Semileptonic Branching Ratios





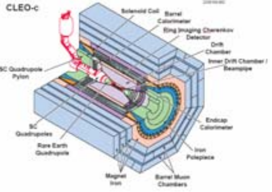
ICHEP Ian Shipsey

Experiment	$Br\left(D^0 \to K^- e^+ \nu_e\right)$ (%)	$Br\left(D^0 \to \pi^- e^+ \nu_e\right)$ (%)	$Br\left(D^+ \to \bar{K}^0 e^+ \nu_e\right)$ (%)
BES	$3.82 \pm 0.40 \pm 0.27$	$0.33 \pm 0.13 \pm 0.03$	$8.47 \pm 1.92 \pm 0.66$
CLEO-c	$3.52 \pm 0.10 \pm 0.25$	$0.25 \pm 0.03 \pm 0.02$	--
MARK III	$3.4 \pm 0.5 \pm 0.4$	$0.39^{+0.23}_{-0.11} \pm 0.04$	$6.0^{+2.2}_{-1.3} \pm 0.7$
PDG 04	3.58 ± 0.18	$0.39^{+0.23}_{-0.11} \pm 0.04$	6.7 ± 0.9

CLEO-c

$$B(D^0 \to K^{*-} e^+ \nu) = (2.07 \pm 0.23 \pm 0.18)\%$$

$$B(D^0 \to \rho^- e^+ \nu) = (0.19 \pm 0.04 \pm 0.02)\%$$

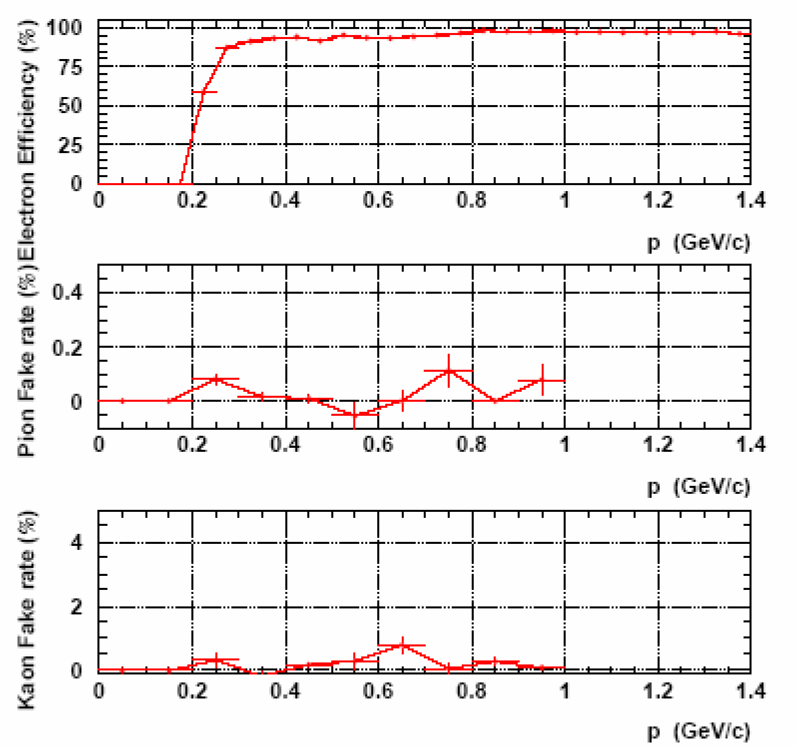


Inclusive D semileptonic decay CLEO-c

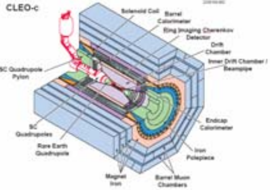
Select a flavor tagged D tag sample and look for an electron in the other D decay. We then determine

$$Y_{sl} = Y_{rs} - Y_{ws} - Y_{fake}$$

CLEO-c

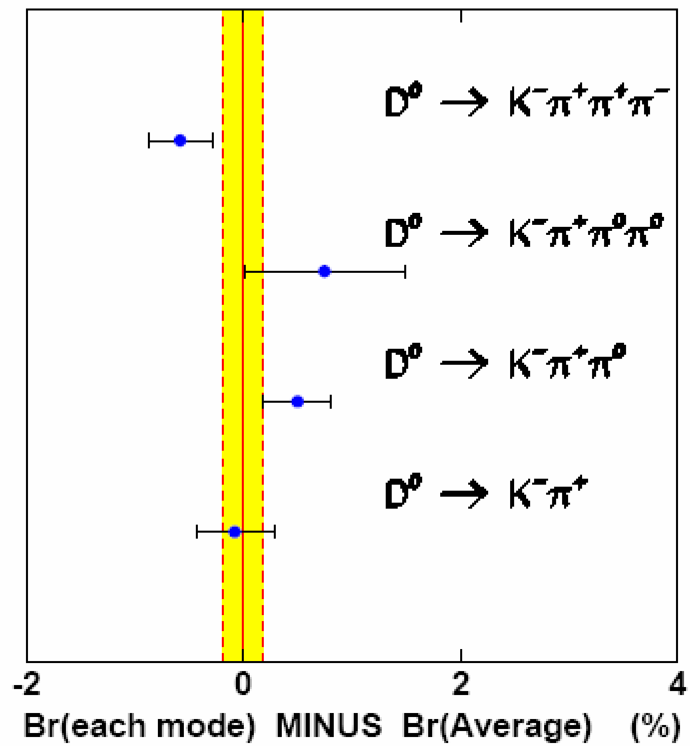


Electron efficiencies and fake rates

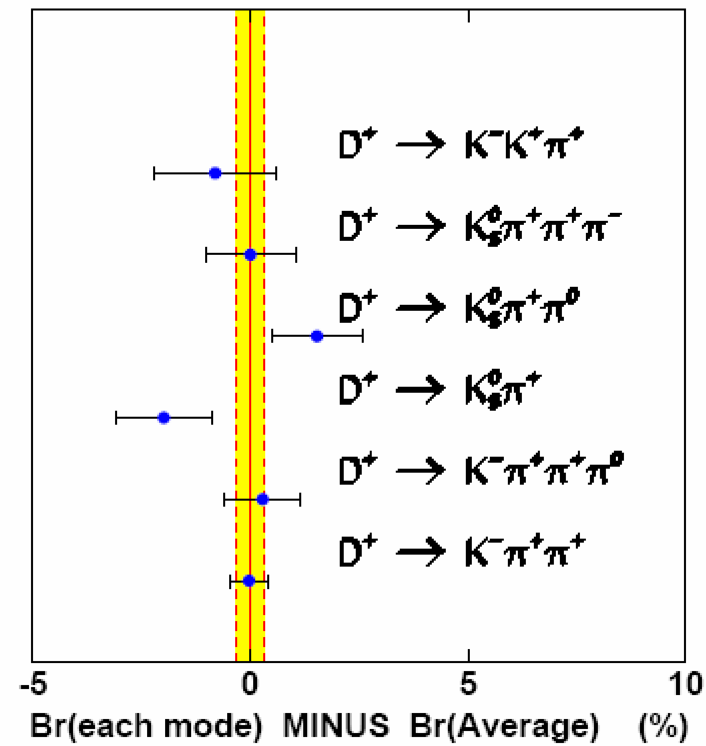


Branching ratios by tag mode

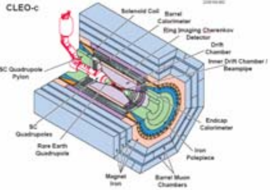
D^0



D^+

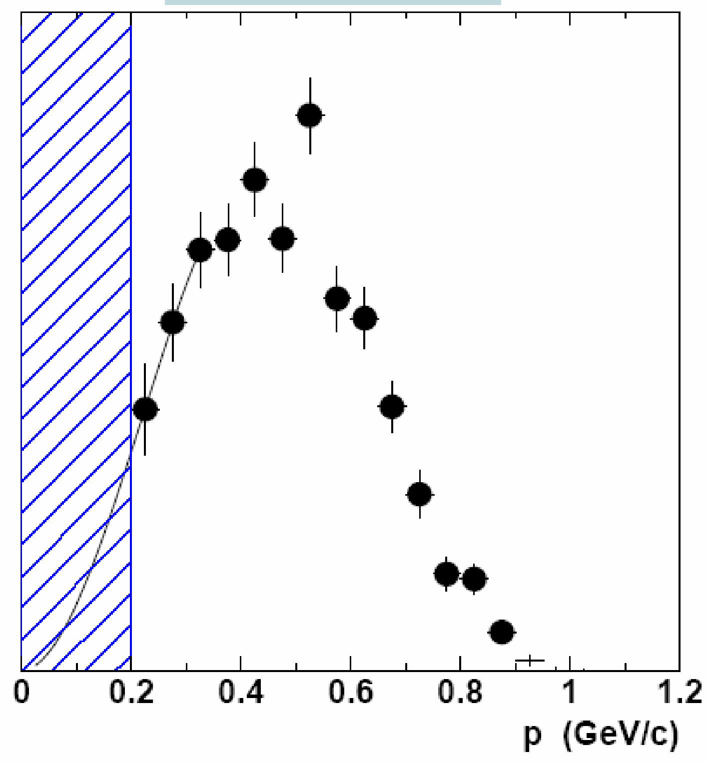


Future goal : D to eX, D_s to eX ~ 4%

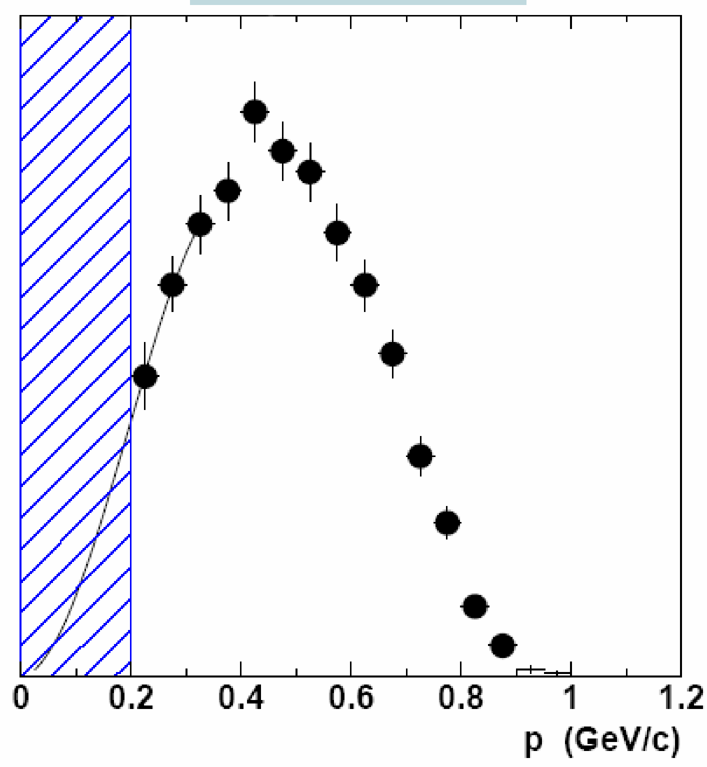


Inclusive electron Spectra CLEO-c

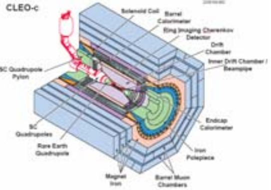
$D^0 \rightarrow X e^+ \nu$



$D^+ \rightarrow X e^+ \nu$



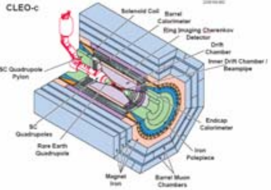
Momentum cutoff (200 MeV/*c*): spectrum extrapolation (~10%)
***D*⁰ modes: subject to Cabibbo suppressed decay (DCSD/SCSD) contributions)-------flavor mis-tagging correction**



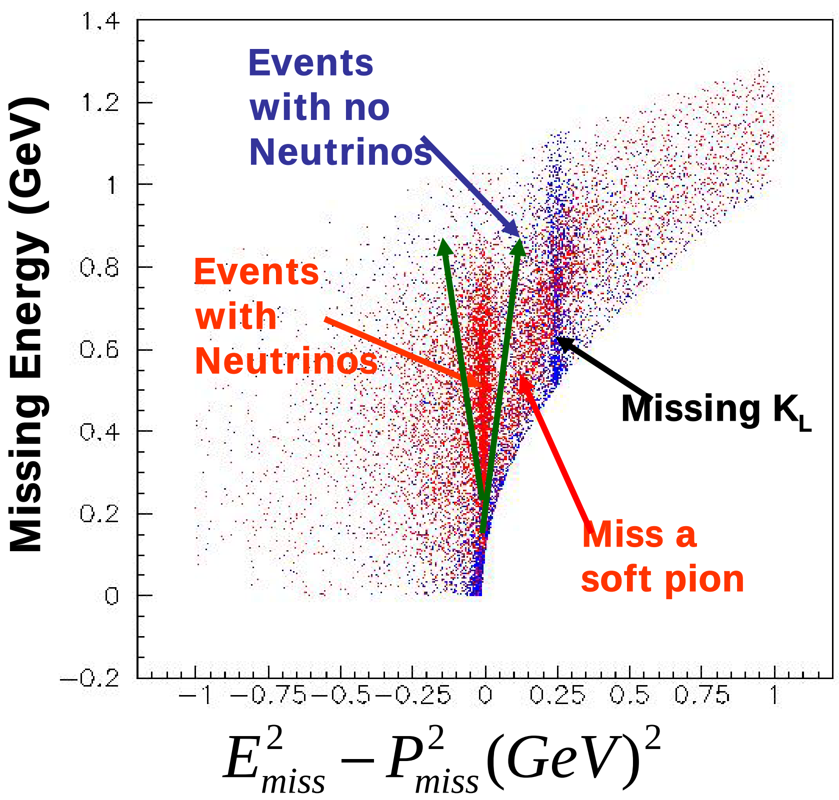
Neutrino reconstruction

Select hadronic events with missing energy
No specific lepton selection

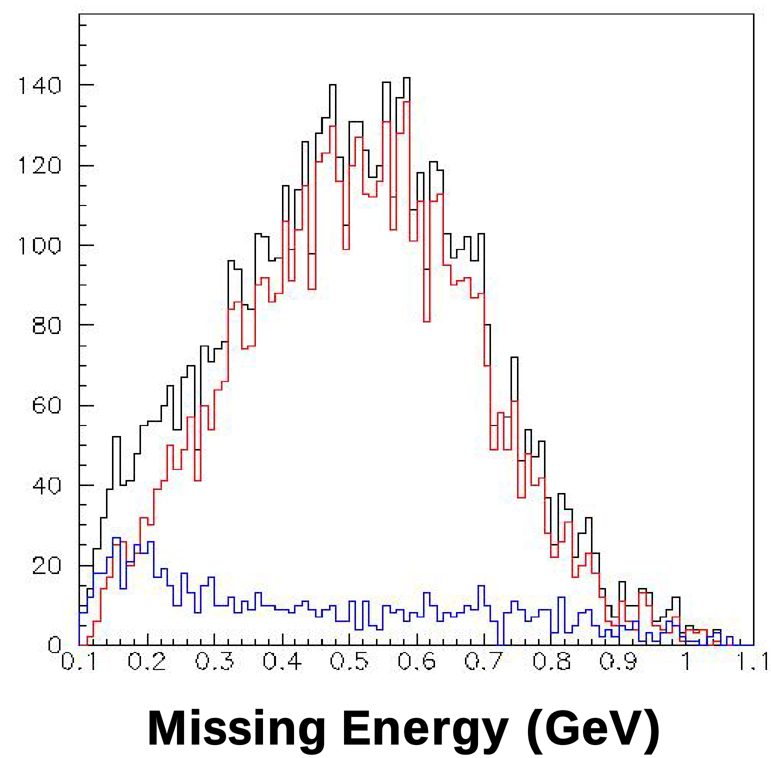
- Add up all signal sidetracks and showers
- Use RICH and dE/dx for particle id
- Get missing 4-momentum
- K_L suppression
- Neutrino vector pointing inside calorimeter
- V Cut to eliminate most non neutrino events

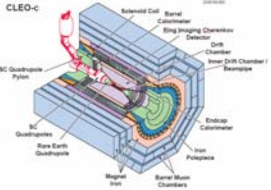


Monte Carlo E_{miss} vs. E^2-P^2



Black = total
Red = with neutrino
Blue = no neutrino

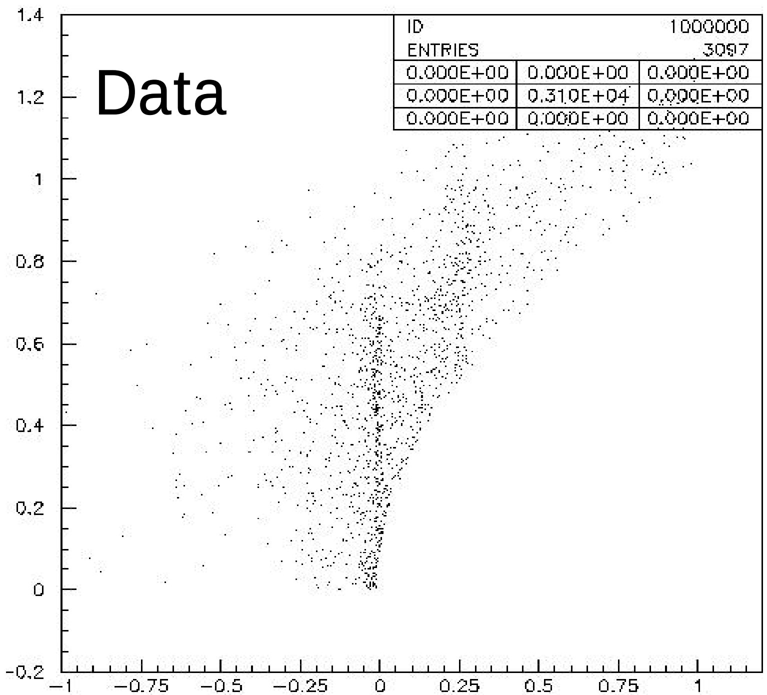




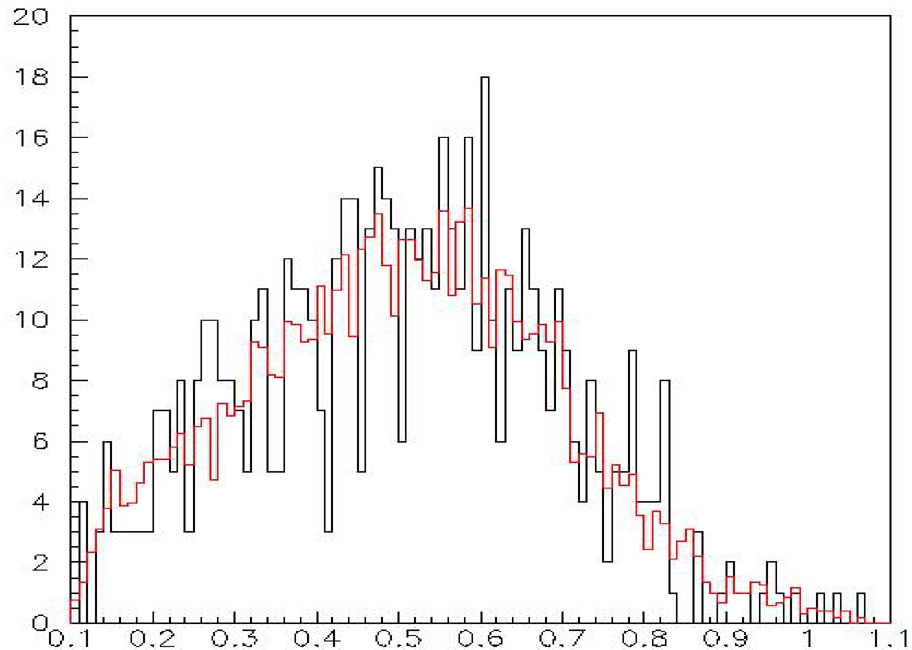
Data MC comparison

Black = data
Red = MC (same luminosity)
No background subtraction
or efficiency corrections

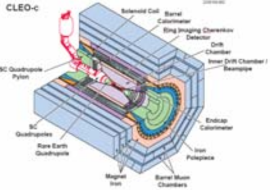
Missing Energy (GeV)



$$E_{miss}^2 - P_{miss}^2 (GeV)^2$$

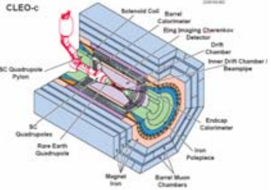


E_{miss} **(GeV)**



Future program of CLEO-c

- **We have just begun a new run at the $\psi(3770)$ with the completed CESR accelerator with 12 wigglers.**
- **We expect a period of increasing luminosity as the new matrix is understood**
- **We will be running 50% of each year**
- **Decisions on E_{cm} for the next year have not yet been made but we expect data sets at more than one energy**



Summary

The analysis of 57.2pb^{-1} at the $\Psi(3770)$ has already produced

- **the best measurement of the D^+ decay constant**
- **Best measurement of D^0 to $\pi^- e^+ \nu$**
- **First observation of D^0 to $\rho^- e^+ \nu$**
- **Hadronic branching ratios comparable to PDG**

We expect to achieve our goal of high precision charm measurements and new results over the next few years