

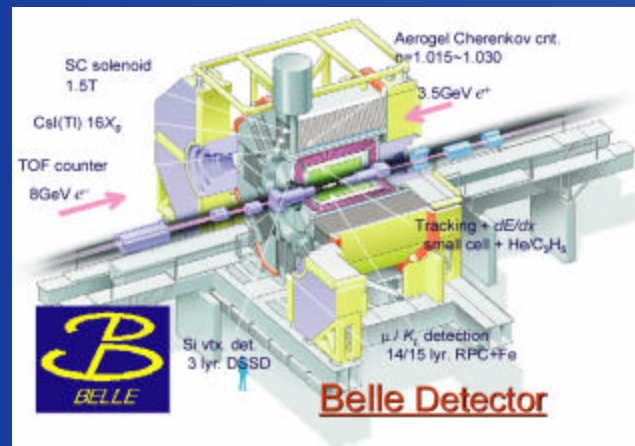
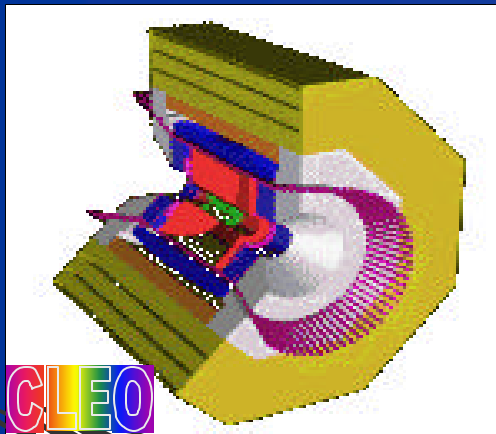
Semileptonic D Decays from CLEO and BELLE

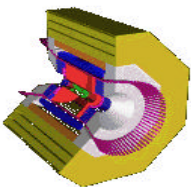
Yongsheng Gao

Southern Methodist University

(CLEO Collaboration)

ICHEP04, Beijing, Aug. 16 - 23, 2004





ICHEP Abstract/Paper



CLEO-III Exclusive D^0 semileptonic Decays

(ICHEP ABS11-0780, CLEO CONF 04-14)

First CLEO-c Inclusive D^0, D^+ semileptonic Decays

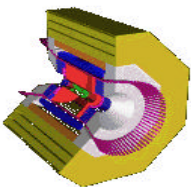
(ICHEP ABS11-0777, CLEO CONF 04-12)

First CLEO-c Exclusive D^0 semileptonic Decays

(ICHEP ABS8-0781, CLEO CONF 04-3)

BELLE Exclusive D^0 semileptonic Decays

(ICHEP ABS11-0706, BELLE CONF 0457)



Outline



Introduction

CLEO-III Semileptonic D Decay Results

- **Exclusive $D^0 \rightarrow K^- l^+ n, p^- l^+ n$**

(ICHEP ABS11-0780, CLEO CONF 04-14, Submitted to PRL)

First CLEO-c Semileptonic D Decay Results

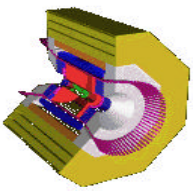
- **Inclusive $D^0 \rightarrow X e^+ n, D^+ \rightarrow X e^+ n$**

(ICHEP ABS11-0777)

- **Exclusive $D^0 \rightarrow K^- e^+ n, p^- e^+ n, K^{*-} e^+ n, ?^- e^+ n$**

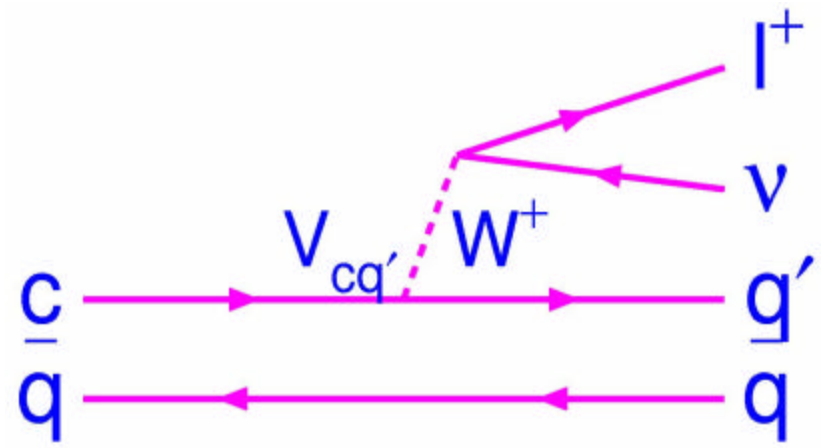
(ICHEP ABS8-0781, CLEO CONF 04-3)

Future Outlook



Why Semileptonic D Decay?

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



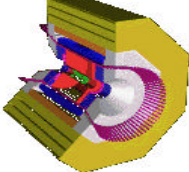
$D^0 \text{ (R) } Xe^{+n}$ and $D^+ \text{ (R) } Xe^{+n}$:

- Inclusive semileptonic BR and spectrum

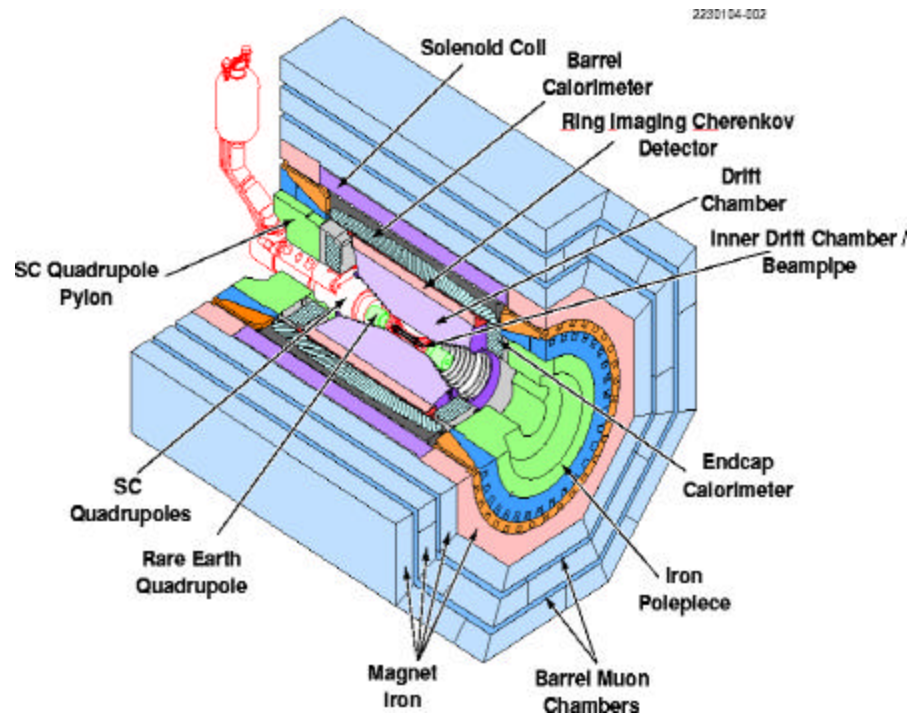
$D^0 \text{ (R) } K^-e^{+n}, p^-e^{+n}$ etc:

$$\frac{d\Gamma}{dq^2} = \frac{G_F^2}{24\pi^3} |V_{cq'}|^2 p_P^3 |f_+(q^2)|^2$$

- Form Factors, V_{cd} , V_{cs} and V_{ub}



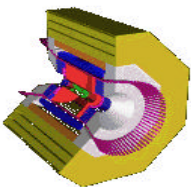
CESR and CLEO



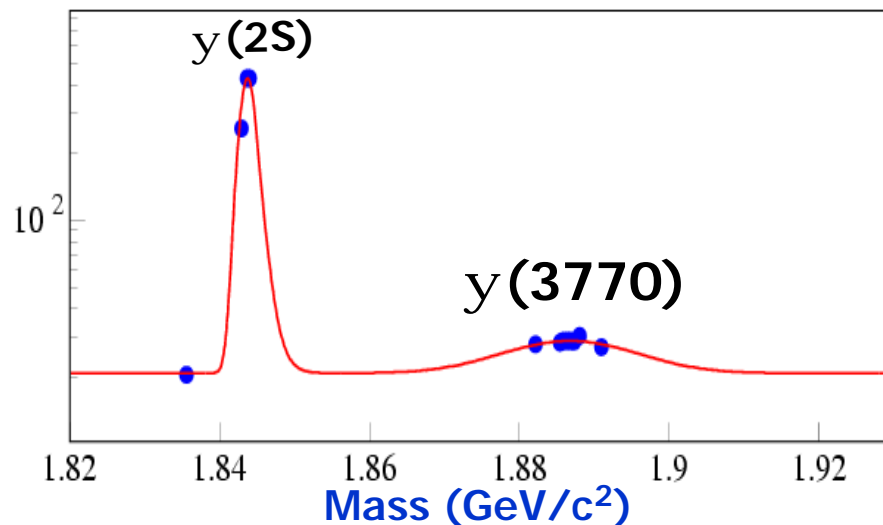
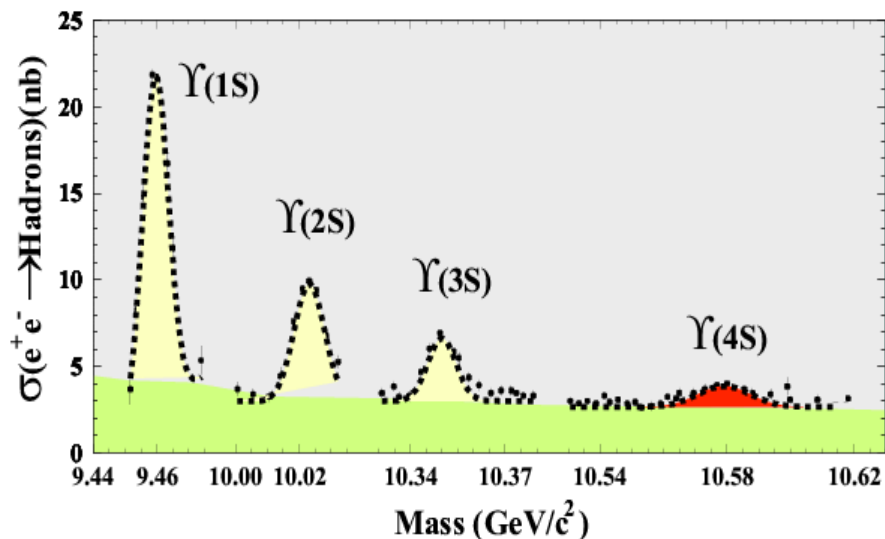
Tracking: **Drift Chambers**

Electron ID: **CsI Cal.**

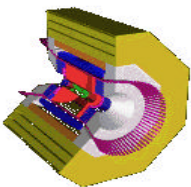
Hadron ID: **RICH**



CLEO Data Samples



	Resonance	Integrated Luminosity
CLEO III	$\sim \psi(4S)$	9.2 fb^{-1}
CLEO-c	$y(3770)$	60 pb^{-1}



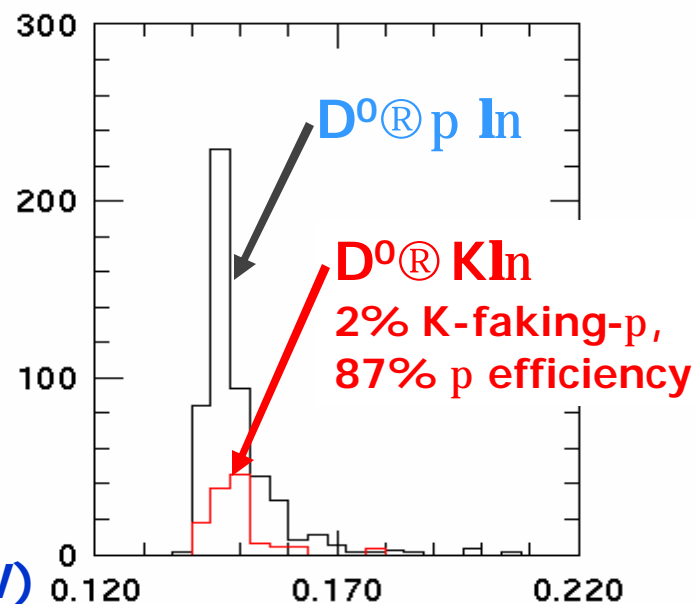
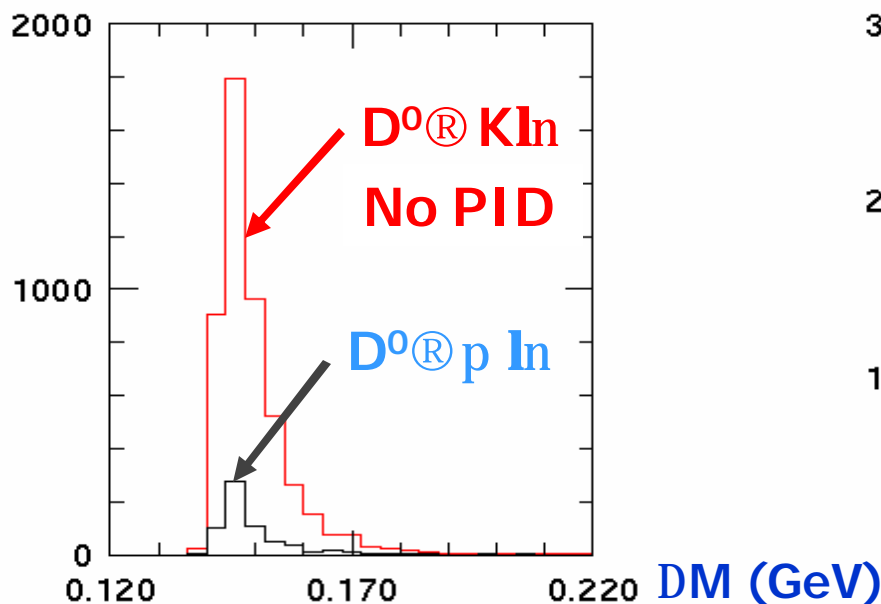
CLEO III $D^0 \circledR K^- l^+ n / p^- l^+ n$



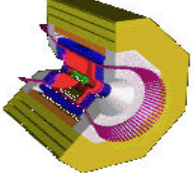
$\sim 7 \text{ fb}^{-1}$ of CLEO-III data near $\psi(4S)$

Event Reconstruction: $D^{*+} \circledR p^+_{\text{slow}} D^0$

Observable: $DM = M_{D^{*+}} - M_{D^0}$ $p(K) l n$



K/p Separation Capability Essential!



CLEO III $D^0 \rightarrow K^- l^+ n / p^- l^+ n$



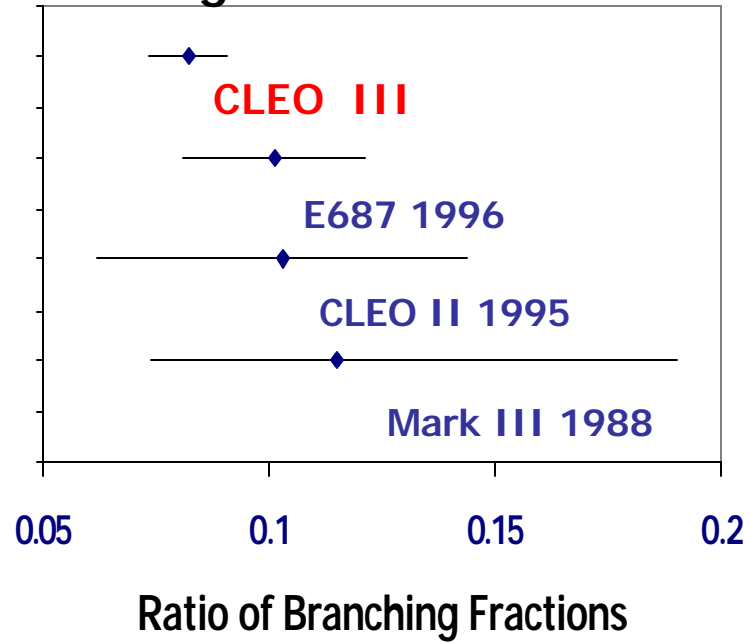
$\sim 7 \text{ fb}^{-1}$ CLEO III data near j (4S)

$$R_0 \equiv \mathcal{B}(D^0 \rightarrow \pi^- e^+ \nu) / \mathcal{B}(D^0 \rightarrow K^- e^+ \nu)$$

$$= 0.082 \pm 0.006 (\text{stat}) \pm 0.005 (\text{sys})$$

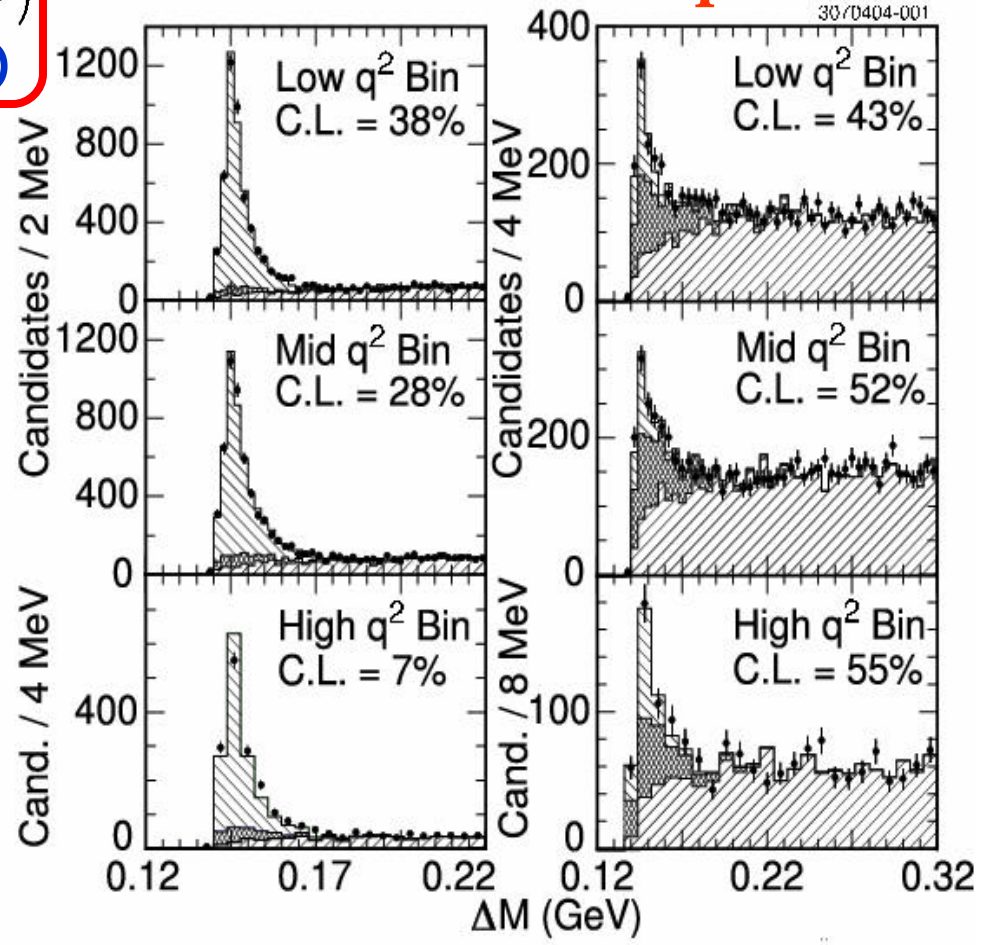
Submitted to PRL

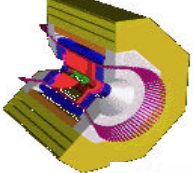
Existing Measurements:



Kln

pln

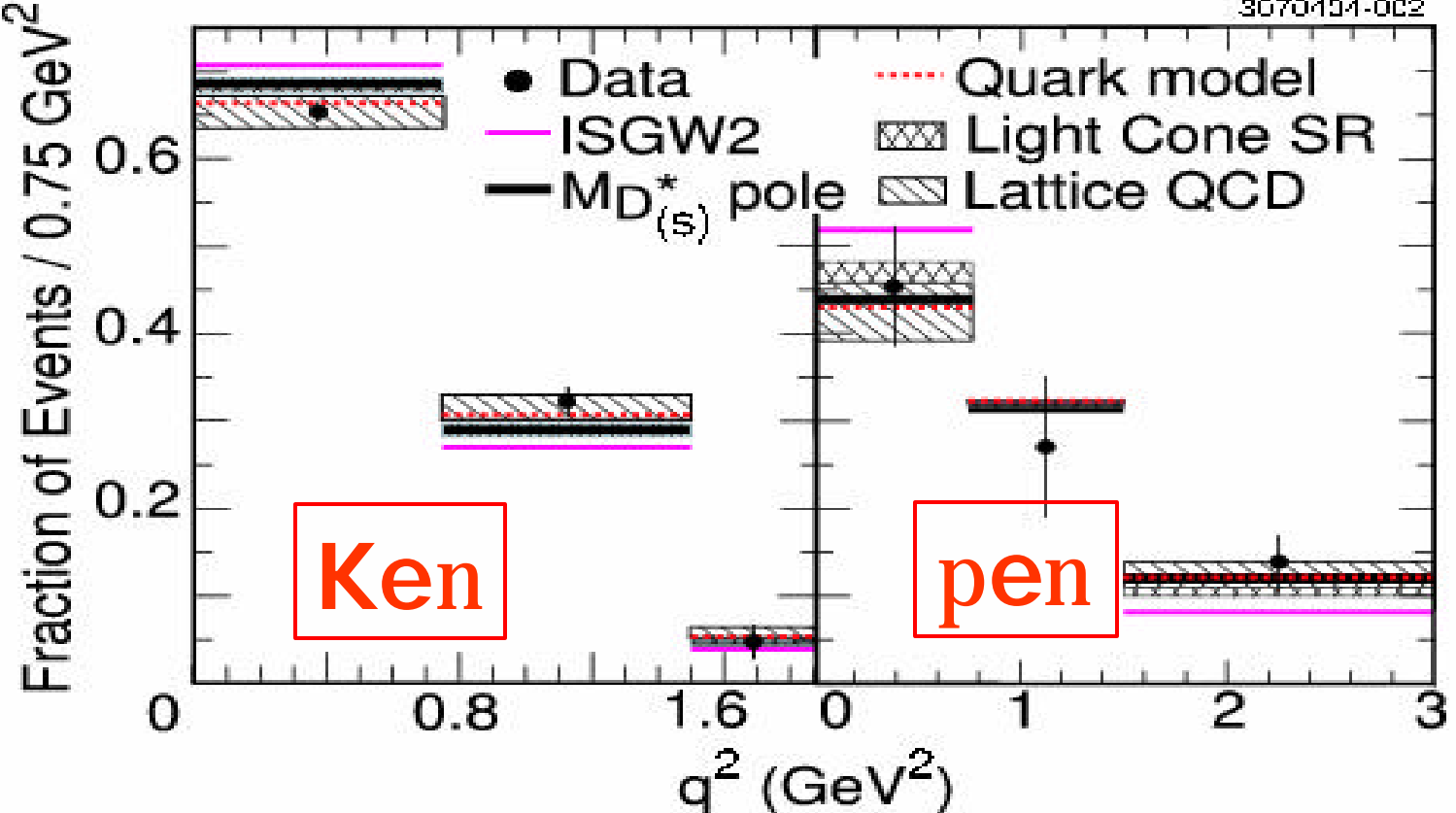




CLEO III $D^0 \rightarrow K^- l^+ n / p^- l^+ n$



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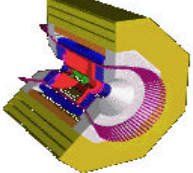


Submitted to PRL

First Measurement

$$\frac{|f_+^\pi(0)|^2 |V_{cd}|^2}{|f_+^K(0)|^2 |V_{cs}|^2} = 0.038_{-0.007-0.003}^{+0.006+0.005}$$

$$\frac{|f_+^\pi(0)|}{|f_+^K(0)|} = 0.86 \pm 0.07_{-0.04}^{+0.06} \pm 0.01$$

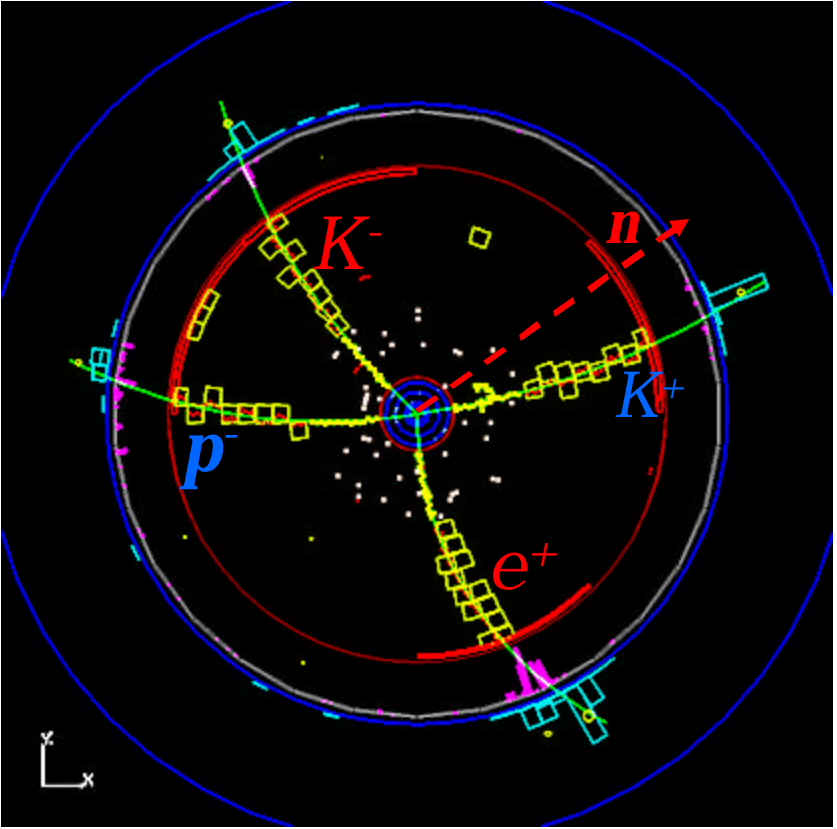
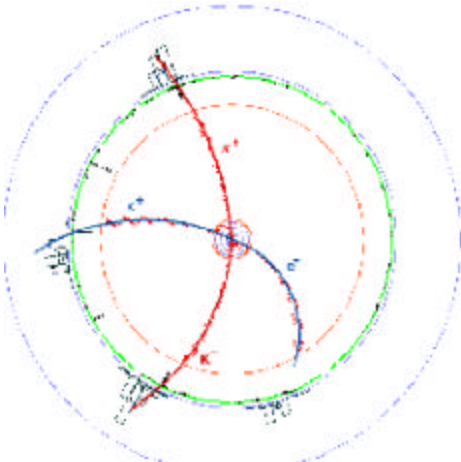
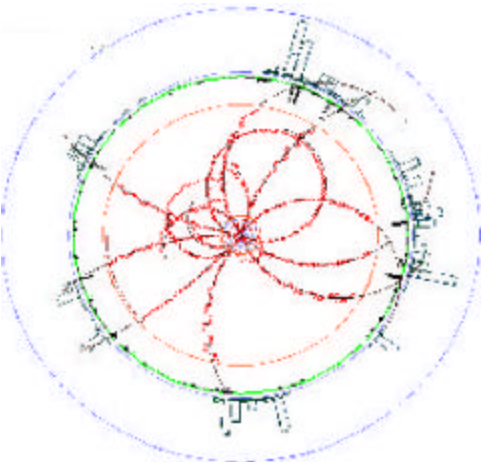


Charm at $\Upsilon(3770)$ vs $\sim j(4S)$



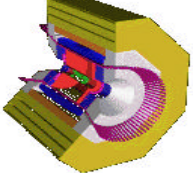
$\sim j(4S)$

$\Upsilon(3770)$

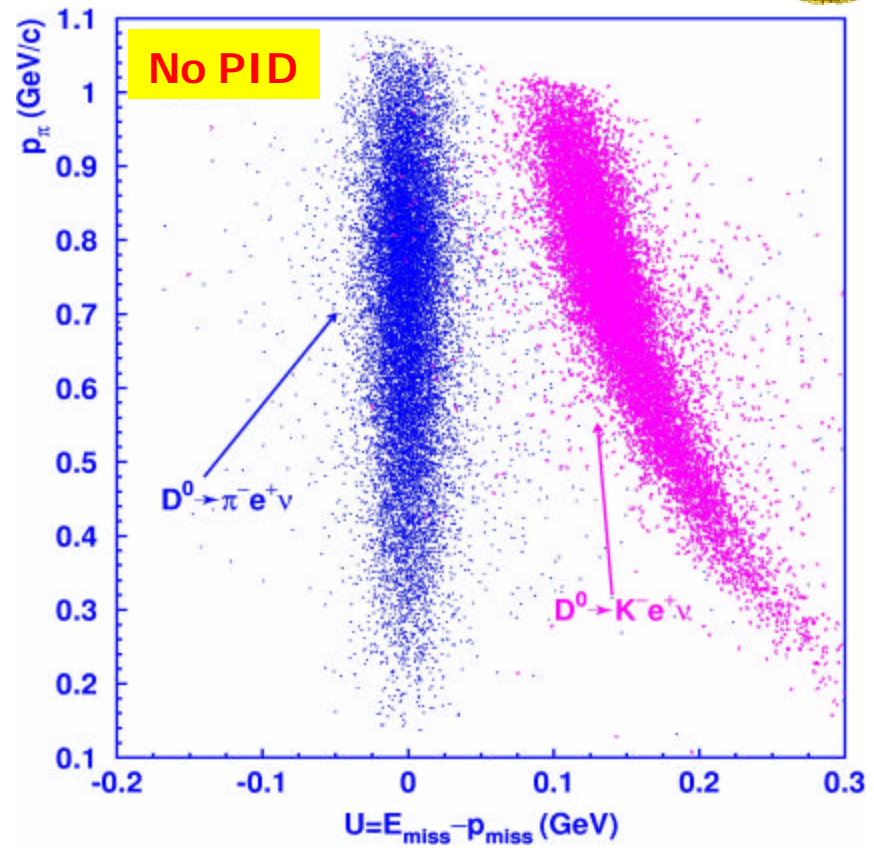
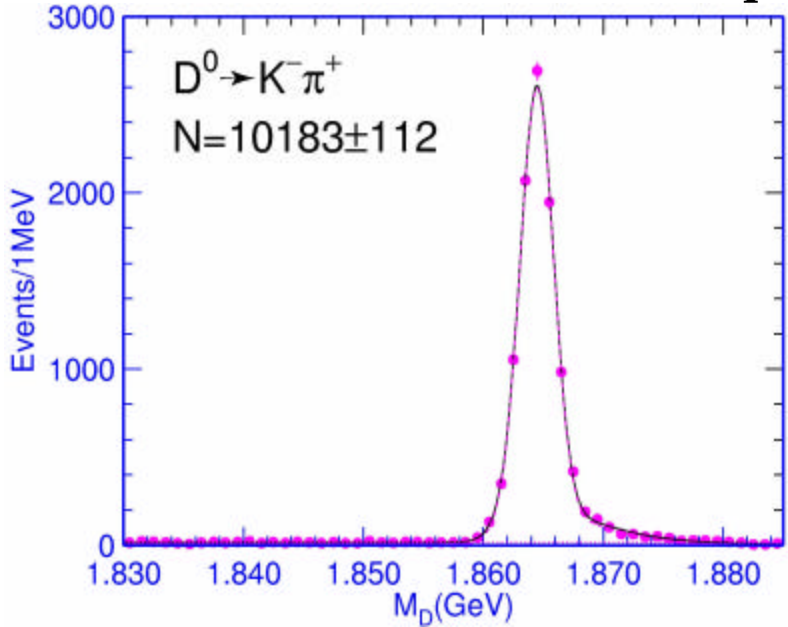
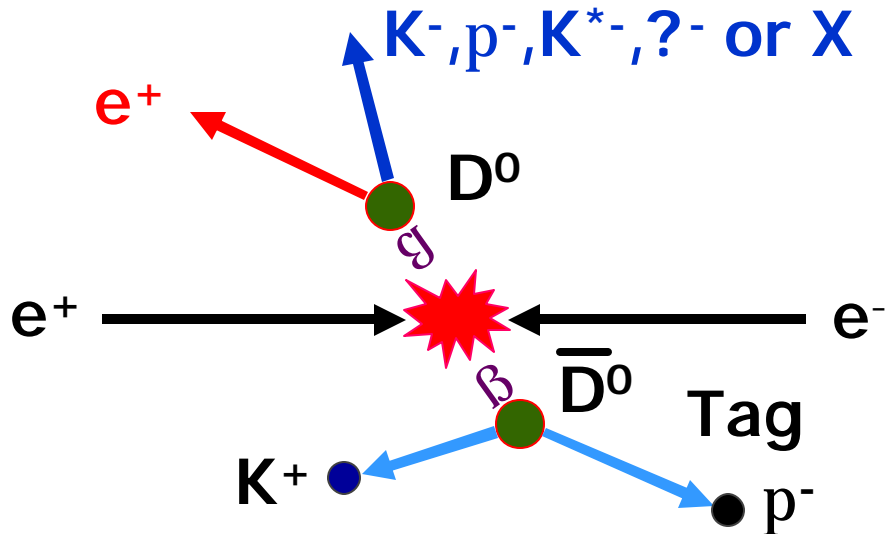


- Large Cross-Section
- Low Multiplicity
- NO Fragmentation
- Kinematics Variables: —
- "Background Free"

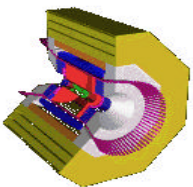
$$\left\{ \begin{array}{l}
 M_D \equiv \sqrt{E_b^2 - |p_D|^2} \\
 ? E = E_b - E_D \\
 U = E_{\text{miss}} - P_{\text{miss}}
 \end{array} \right.$$



Unique Kinematics at $\Upsilon(3770)$



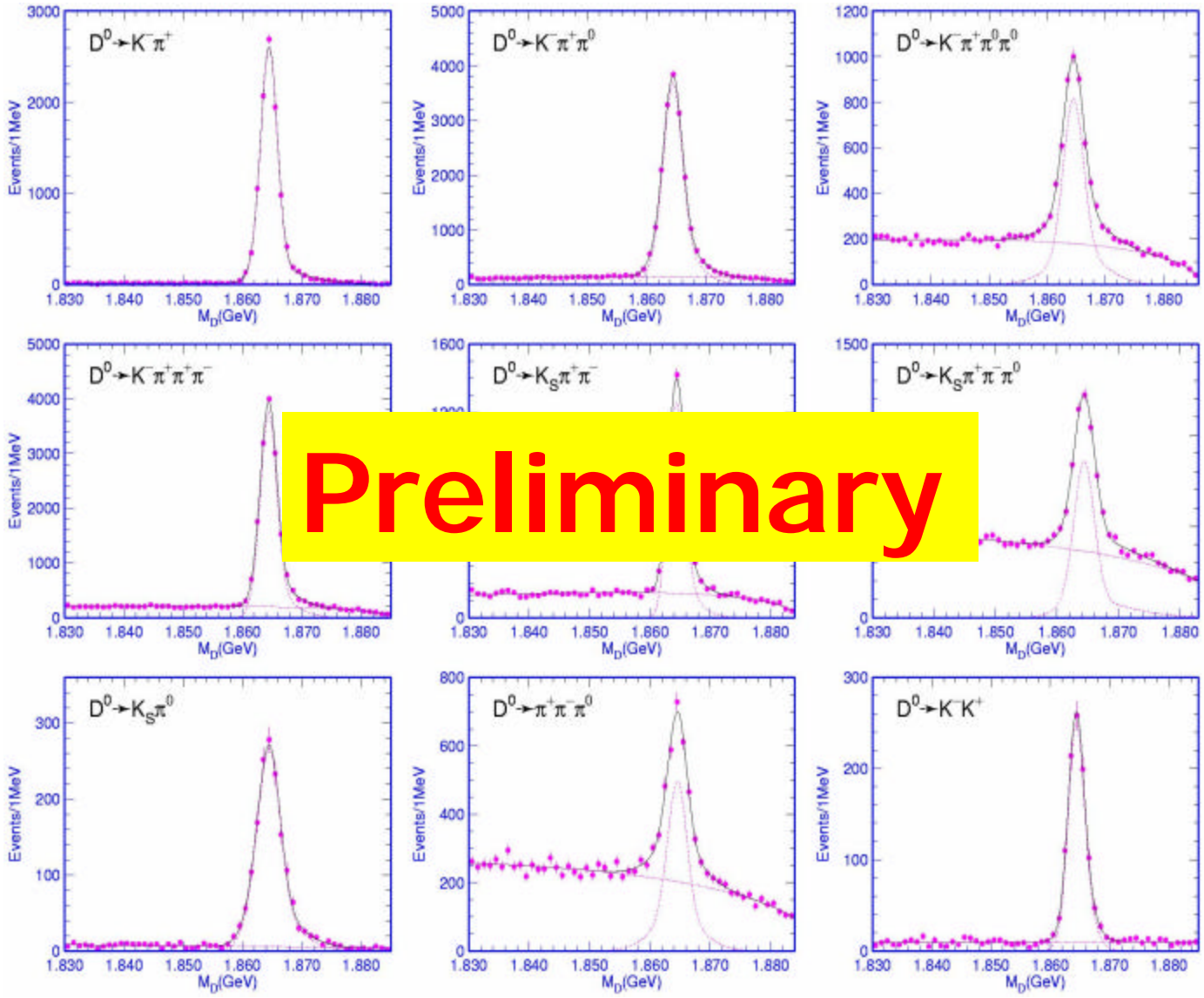
$$\mathcal{B} = \frac{N_{\text{signal}} / \epsilon_{\text{signal}}}{N_{\text{tag}} / \epsilon_{\text{tag}}}$$



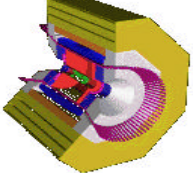
Fully Reconstructed D^0 (Tag)

From 60 pb⁻¹ at $\Upsilon(3770)$

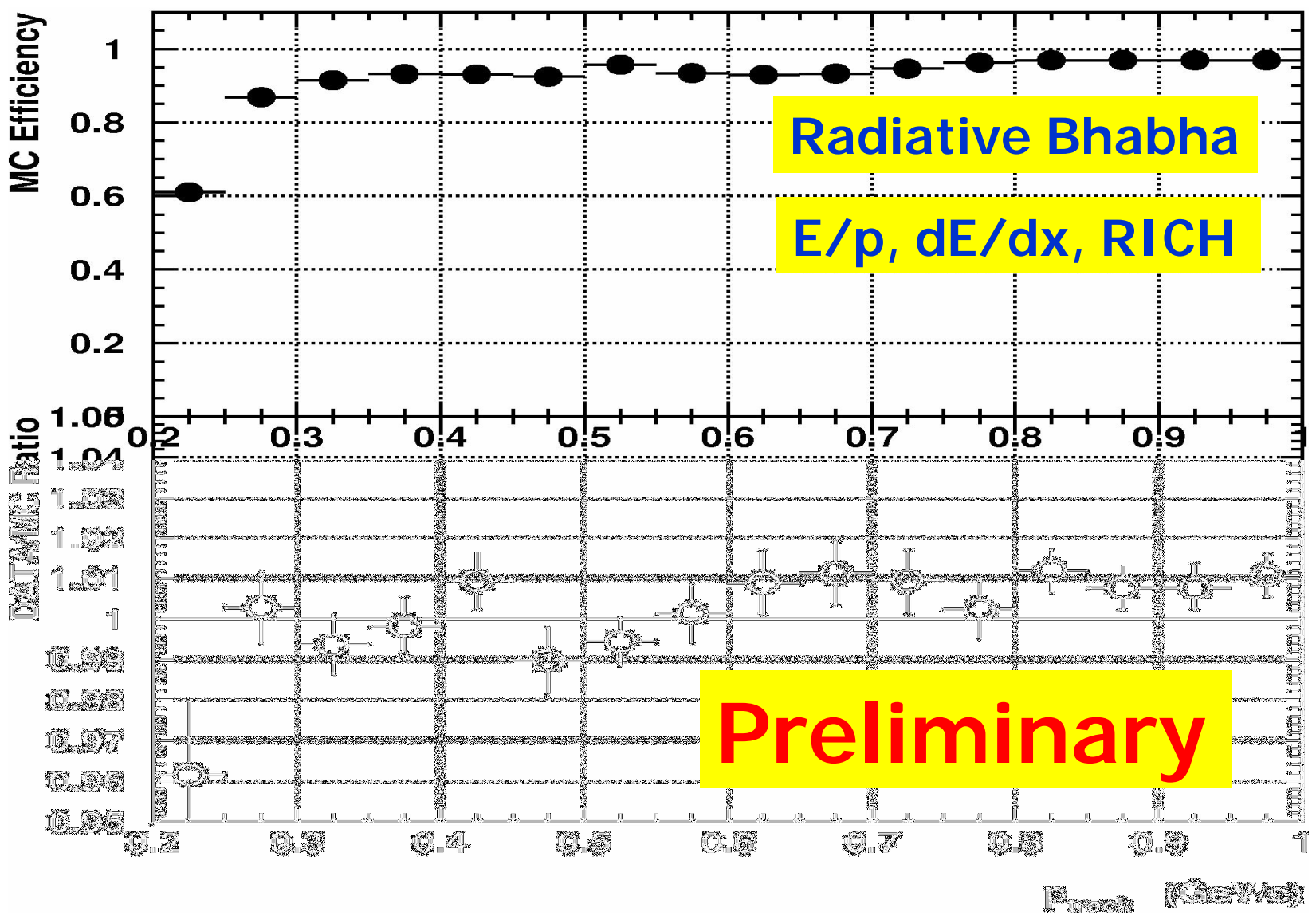
60K fully reconstructed D^0

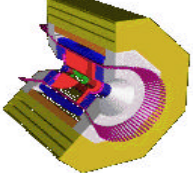


Preliminary



Electron Identification

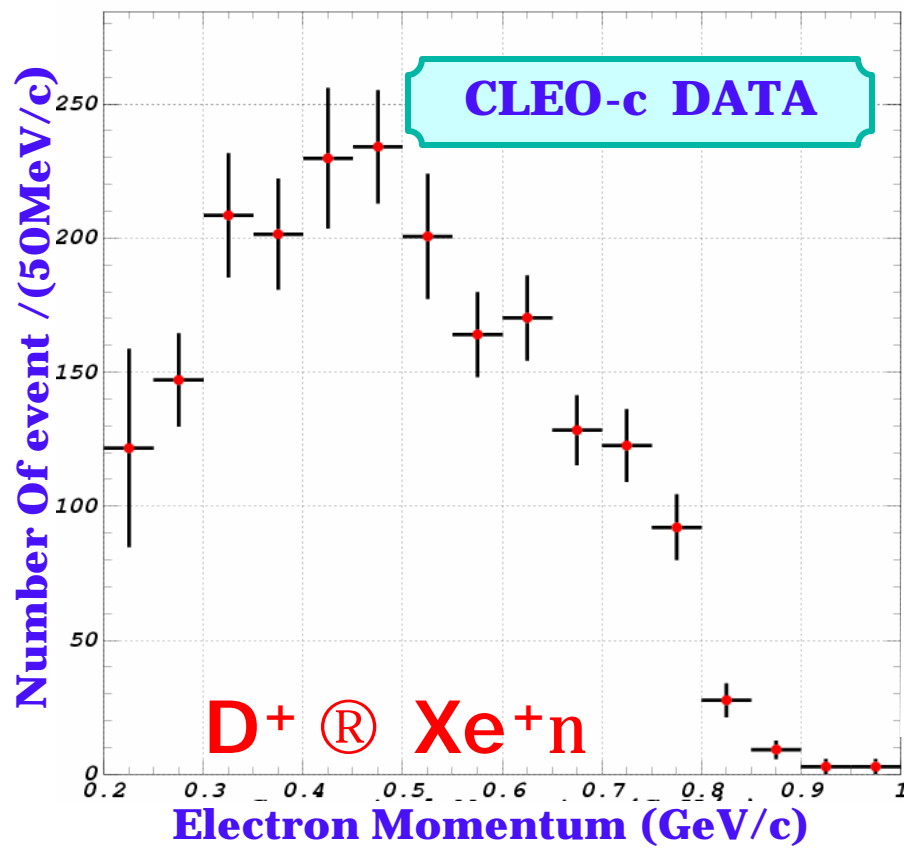




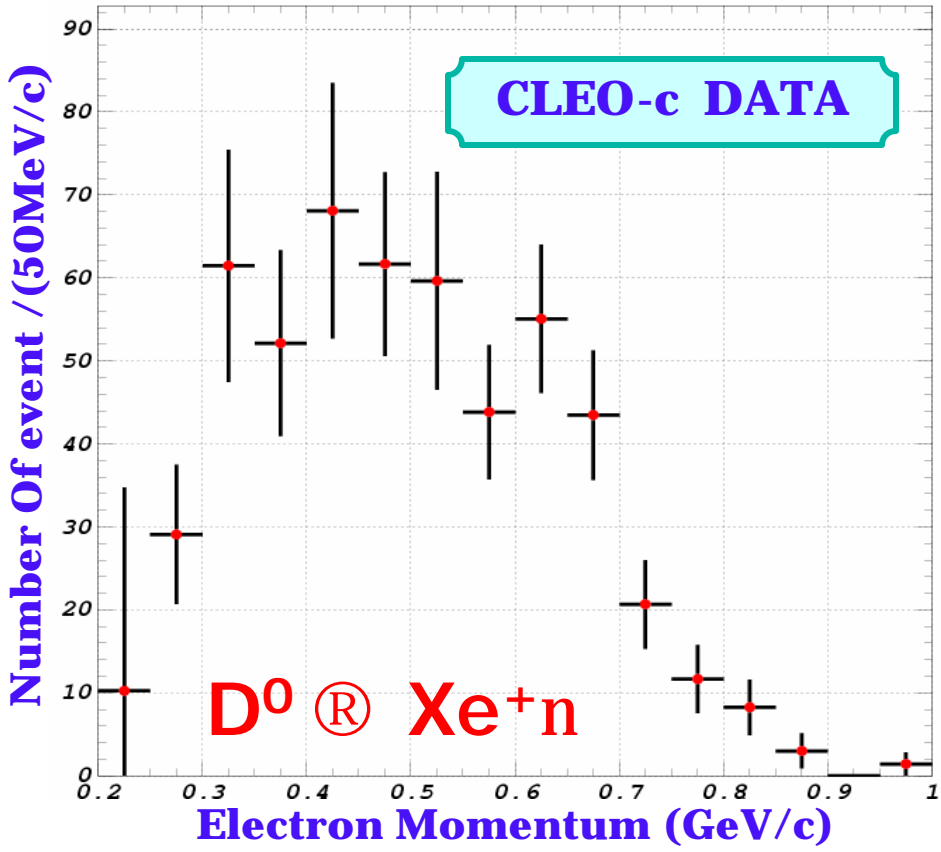
Corrected Electron Spectra



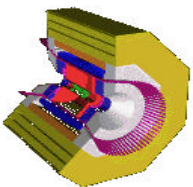
From 60 pb⁻¹ of first CLEO-c data: **Preliminary**



Stat. Uncertainty ~ 0.6%
PDG: BR = (17.2±1.9)%



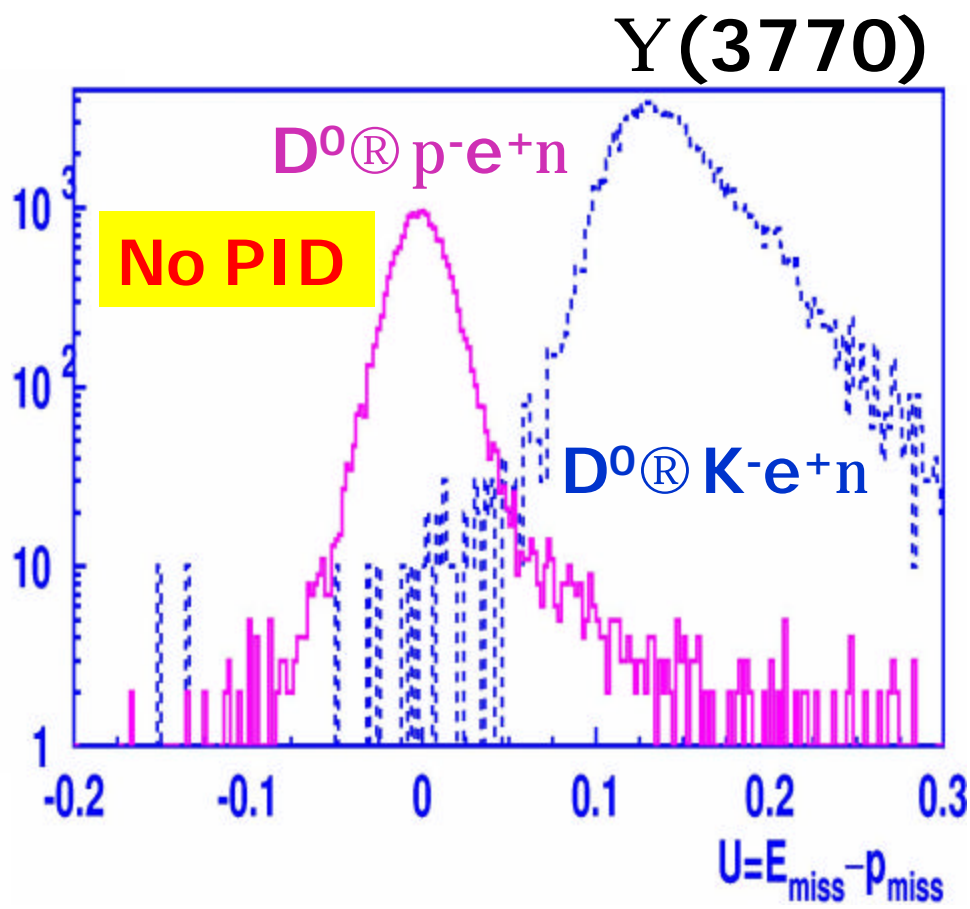
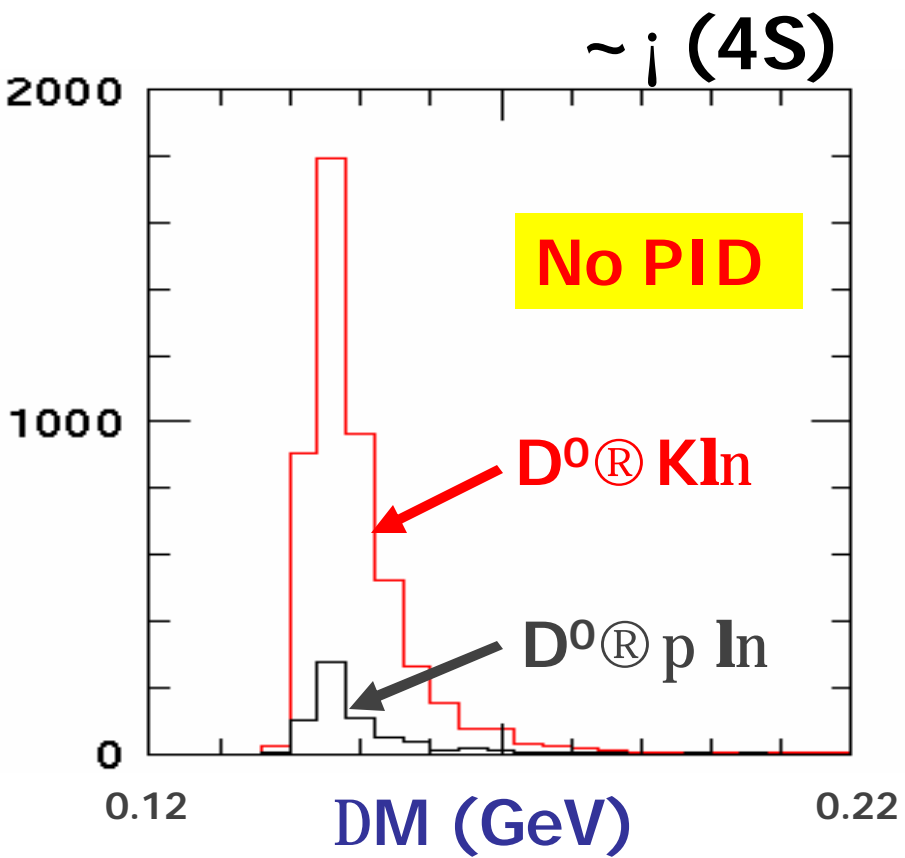
Stat. Uncertainty ~0.5%
PDG: BR = (6.75±0.29)%

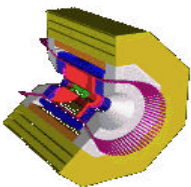


Crossfeed bw $D^0 \oplus K^-e^+n, p^-e^+n$

$\sim j(4S)$: NO separation in ?M

$Y(3770)$: WELL separated in U

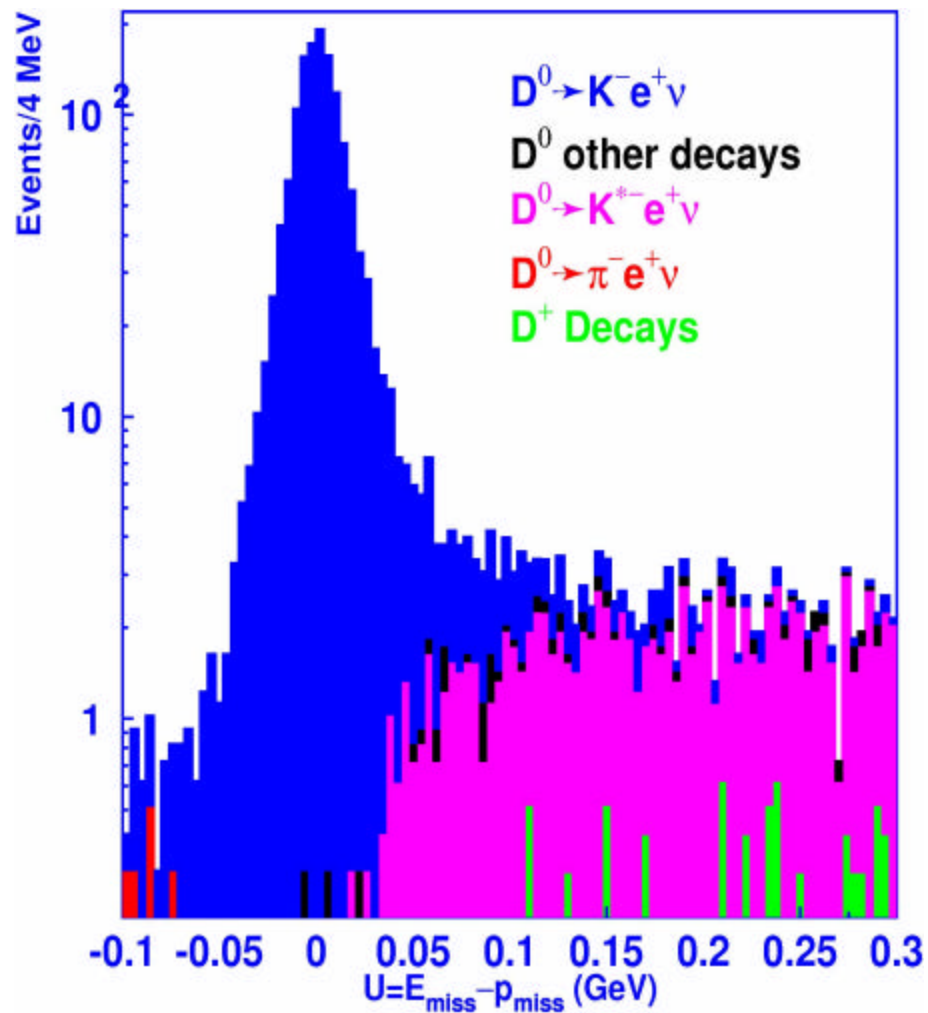
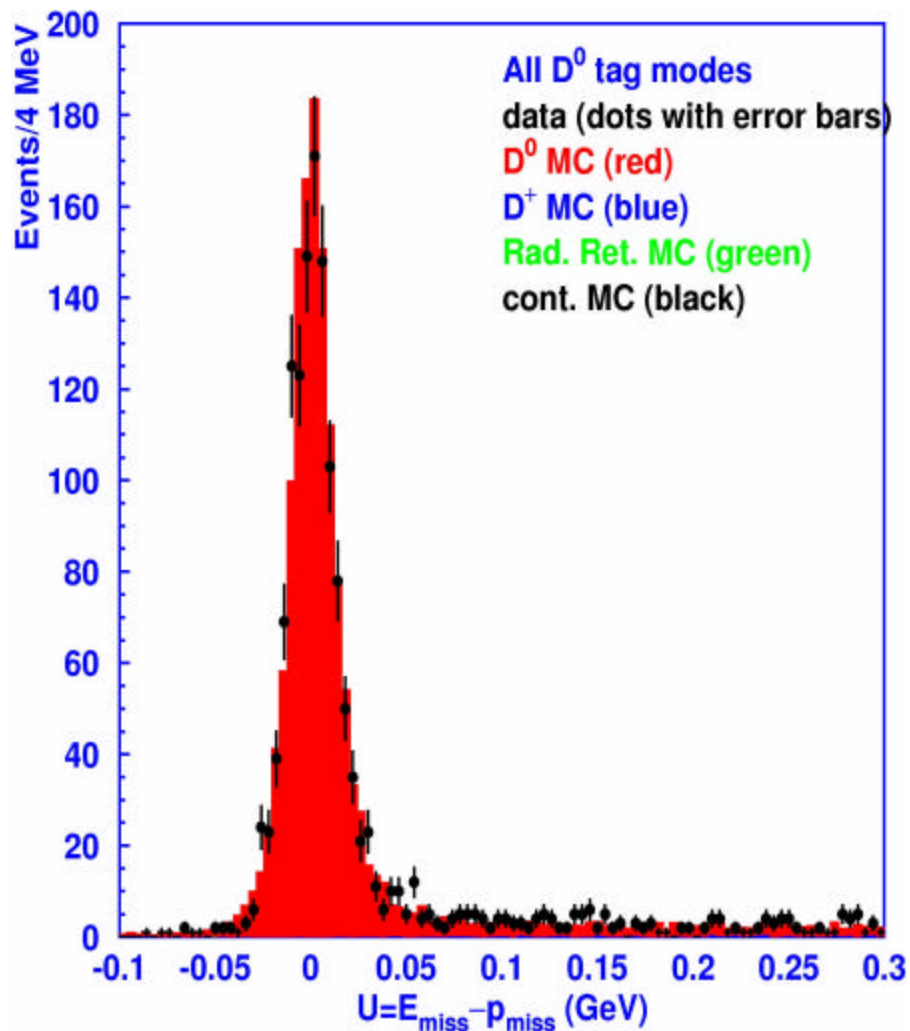


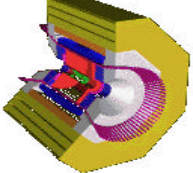


CLEO-c: $D^0 \rightarrow K^- e^+ \pi^0$ Results

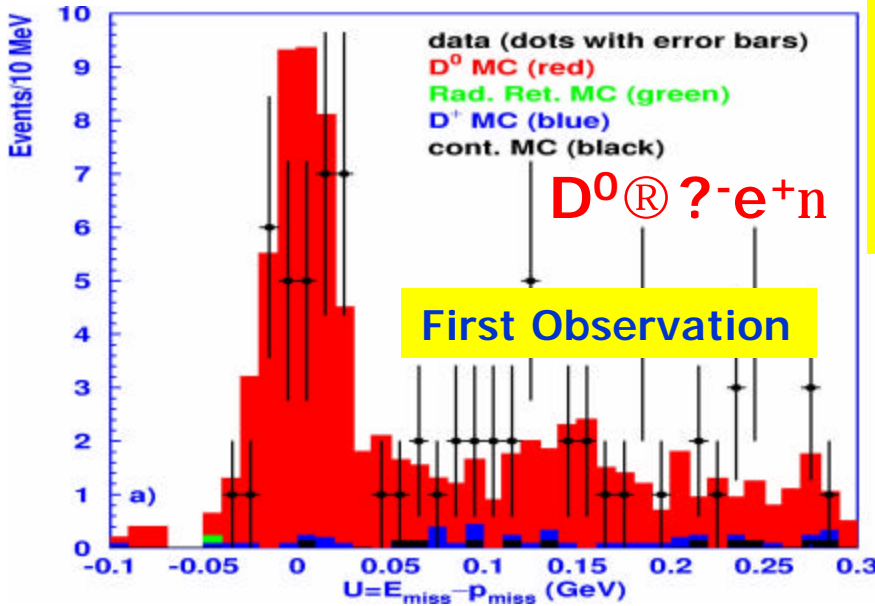
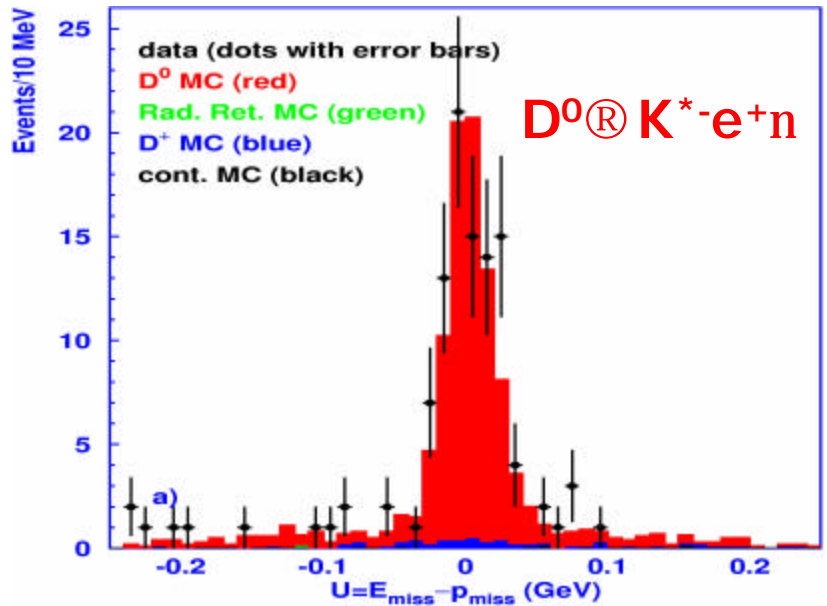
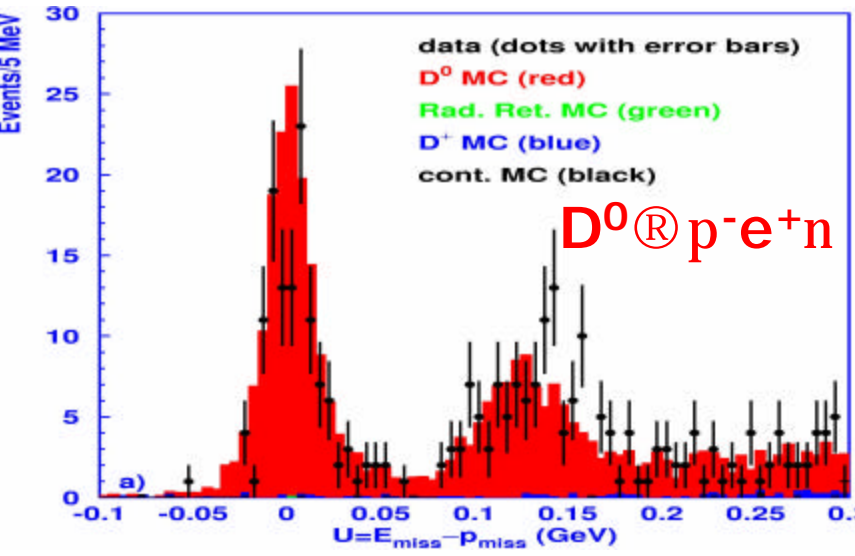
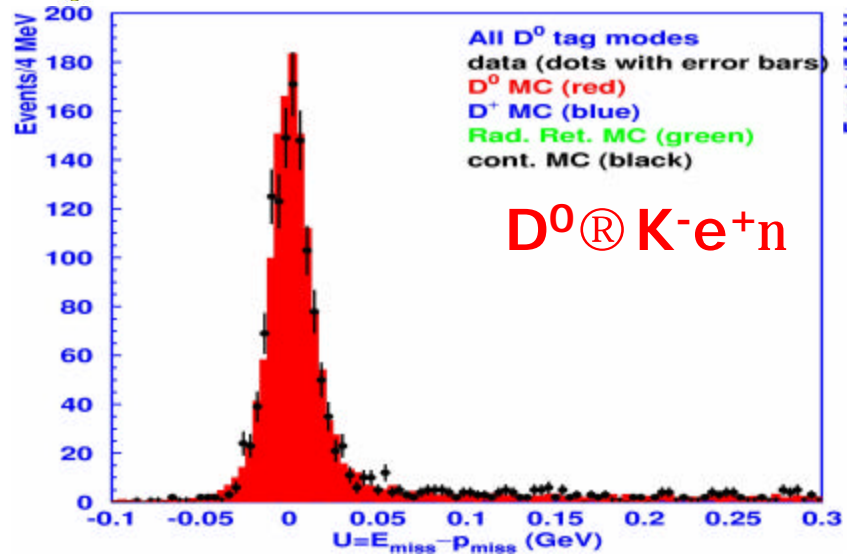


From 60 pb^{-1} CLEO-c data: Preliminary

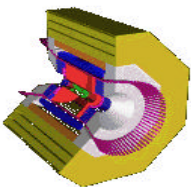




CLEO-c Exclusive D^0 Semileptonic



Preliminary



First CLEO-c Results



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

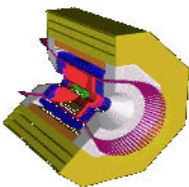
Preliminary

Improved measurements of absolute Branching Fractions

First Observation of $D^0 \rightarrow \rho^- e^+ \nu$

Both Statistic/Systematic errors limited by the 60 pb⁻¹ data!

Expect $\sim 3 \text{ fb}^{-1}$ of CLEO-c data in one year!

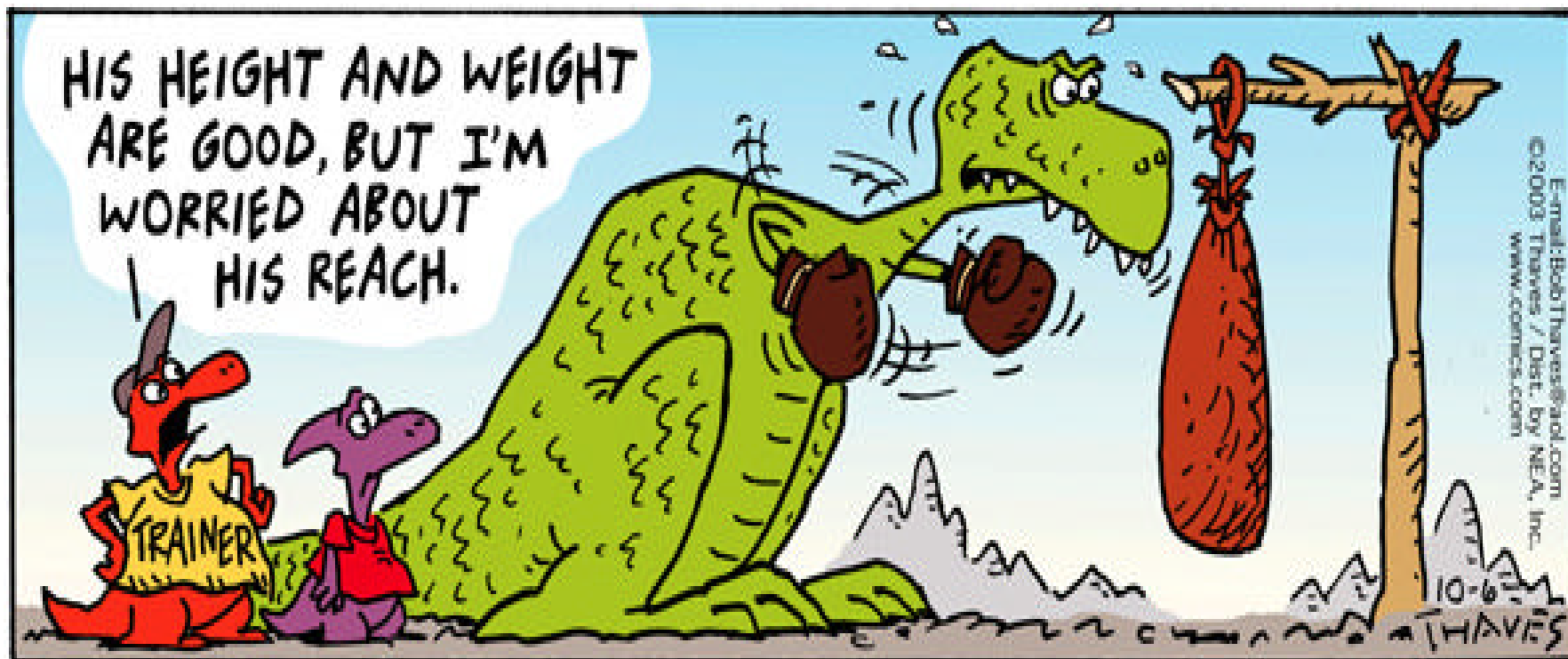


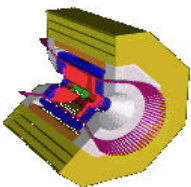
Summary



"Background Free" at $Y(3770)$

Limiting Factor: 60 pb^{-1} of data sample!





CLEO-c Outlook



2005: $\psi(3770) \sim 3 \text{ fb}^{-1}$

18 million DD evts, 3,6 million *tagged* D decays
(150 times MARK III)

2006: $\sqrt{S} \sim 4140 \text{ MeV} \sim 3 \text{ fb}^{-1}$

1.5 million $D_s D_s$ evts, 0.3 million *tagged* D_s
(480 times MARK III, 130 times BES)

2007: $\psi(3100)$, $\sim 1 \text{ fb}^{-1}$ & $\psi(3686)$

~ 1 Billion J/ψ decays

(170 times MARK III, 20 times BES II)

C
L
E
O
C

Many very precision charm results:

Form factors, Absolute BR, CKM elements ...

CLEO-c Yellow Book, CLNS-01/1742