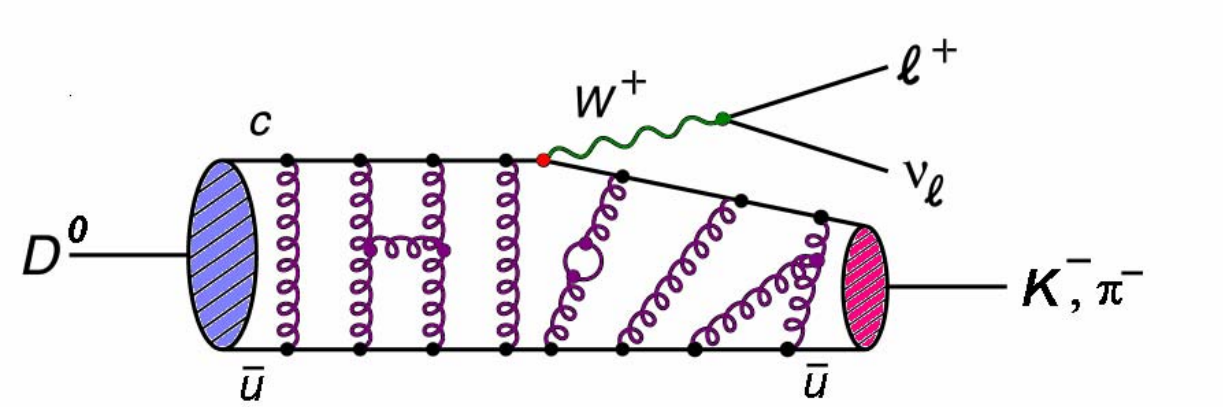
Charm semileptonic decays



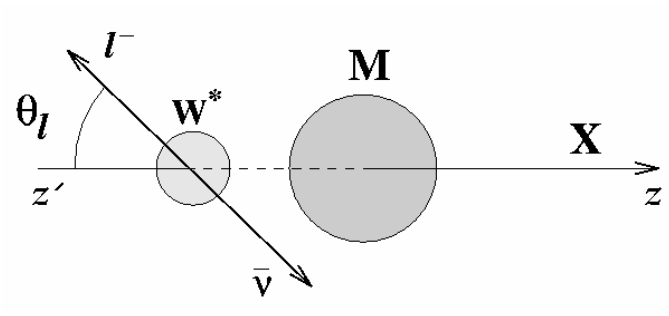
Physics goals

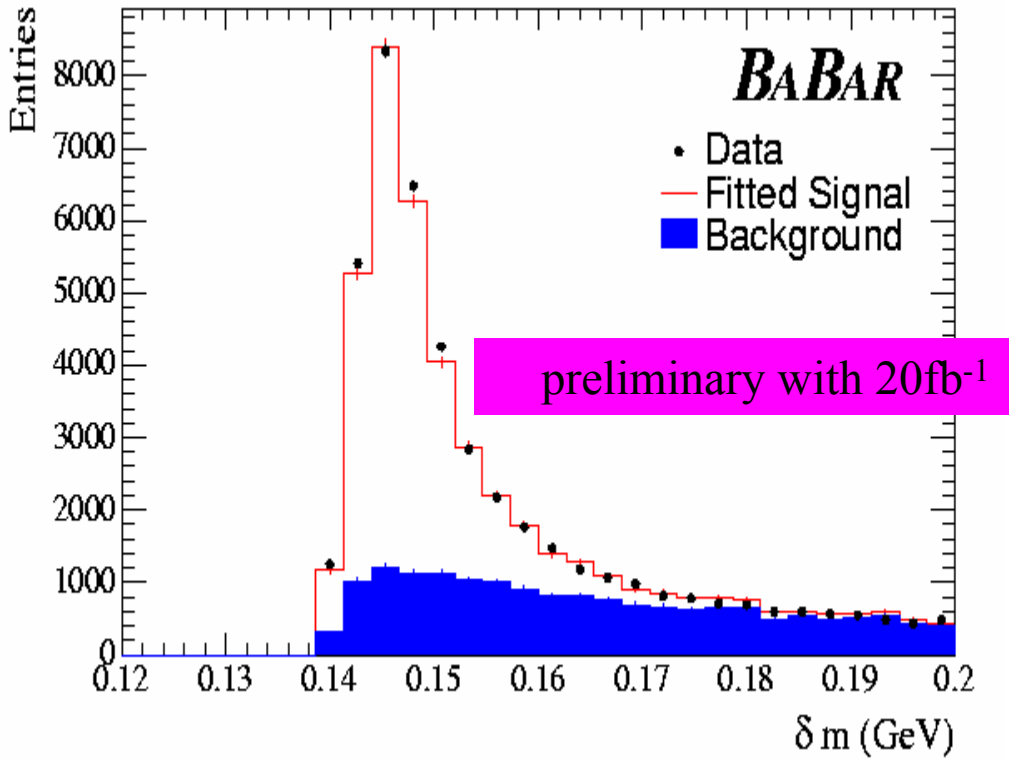
- $F_i(q^2)$ accurate measurements↔ validation of LQCD computations
- From D to B ↔ improve accuracy on V_{ub}
- Study 0^+ states (Kπ, ππ, KK) ↔ chiral symmetry, rare B decays

Where?

- Inside BaBar: few people working on c sl. decays
- CLEO-c: D at rest, running (expect 750 pb^{-1} on $D^{0,+}$)
- BELLE: develop an approach « à la CLEO-c »

Dl3 decays





preliminary with 20fb^{-1}

Properties

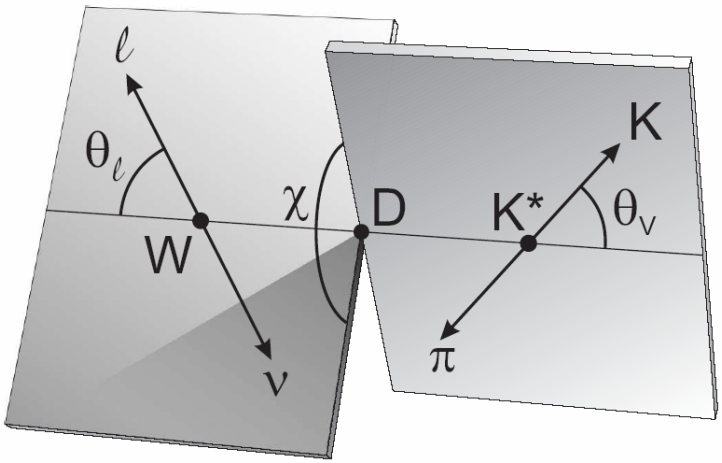
- One hadronic form factor (m_l=0)
- Angular distribution known: $\sin^2(\theta_l)$
- Compare $F(q^2)$ with LQCD

Statistics

- CLEO_c: 6500 K$^-$ev (280pb^{-1}) → 15-20 K with total stat.
- BELLE : 2500 K$^-$ev (280fb^{-1})
- BaBar: 1000 K$^-$ev (1fb^{-1}) with higher backg. and less resolution

$\delta m = m(D\pi) - m(D)$

Dl4 decays



$$\frac{d^5\Gamma}{dq^2 ds_{23} d\cos\theta d\chi d\cos\theta^*} = \frac{G_F^2 |V_{cs}|^2 q^2 \sqrt{a_2} X}{96(2\pi)^6 m_1^3} \sum_i l_i H_i,$$

$$\begin{aligned}
H_U &= C_1 \left(|g|^2 + \frac{|h|^2 X^2}{m_1^4} \right) \\
H_L &= \frac{1}{q^2 m_1^2} |X f + C_2 g|^2 \\
H_T &= \frac{-1}{2} C_1 \left(|g|^2 - \frac{|h|^2 X^2}{m_1^4} \right) \\
H_V &= \frac{-X}{m_1^2} C_1 \Im\{h^* g\} \\
H_F &= \frac{X}{m_1^2} C_3 \Im\{h^* [X f + C_2 g]\} \\
H_I &= C_3 \Re\{g^* [X f - C_2 g]\} \\
H_P &= \frac{2X}{m_1^2} C_1 \Re\{g^* h\} \\
H_A &= \frac{X}{m_1^2} C_3 \Re\{h^* [X f + C_2 g]\} \\
H_N &= C_3 \Im\{g^* X f\}
\end{aligned}$$

3 form factors

$$l_U = \frac{3}{8}(1+\cos^2\theta),\ l_L = \frac{3}{4}\sin^2\theta,\ l_T = \frac{3}{4}\sin^2\theta\cos(2\chi),$$
$$l_V = -\frac{3}{4}\sin^2\theta\sin(2\chi),\ l_P = \frac{3}{4}\cos\theta,\ l_F = \frac{3}{2\sqrt{2}}\sin(2\theta)\sin\chi,$$
$$l_I = -\frac{3}{2\sqrt{2}}\sin(2\theta)\cos\chi,\ l_N = \frac{3}{\sqrt{2}}\sin\theta\sin\chi,\ l_A = -\frac{3}{\sqrt{2}}\sin\theta\cos\chi$$

observables amenable. Furthermore, by parametrizing the functions f, g, h and identifying their phases with πK phase shifts (a consequence of Watson's theorem), the partial wave expansion of f, g, and h read

$$f = \tilde{f}_s e^{i\delta_0^{1/2}} + \tilde{f}_p e^{i\delta_1^{1/2}} \cos\theta^* + \ldots,$$
$$g = \tilde{g}_p e^{i\delta_1^{1/2}} + \ldots,$$
$$h = \tilde{h}_p e^{i\delta_1^{1/2}} + \ldots.$$

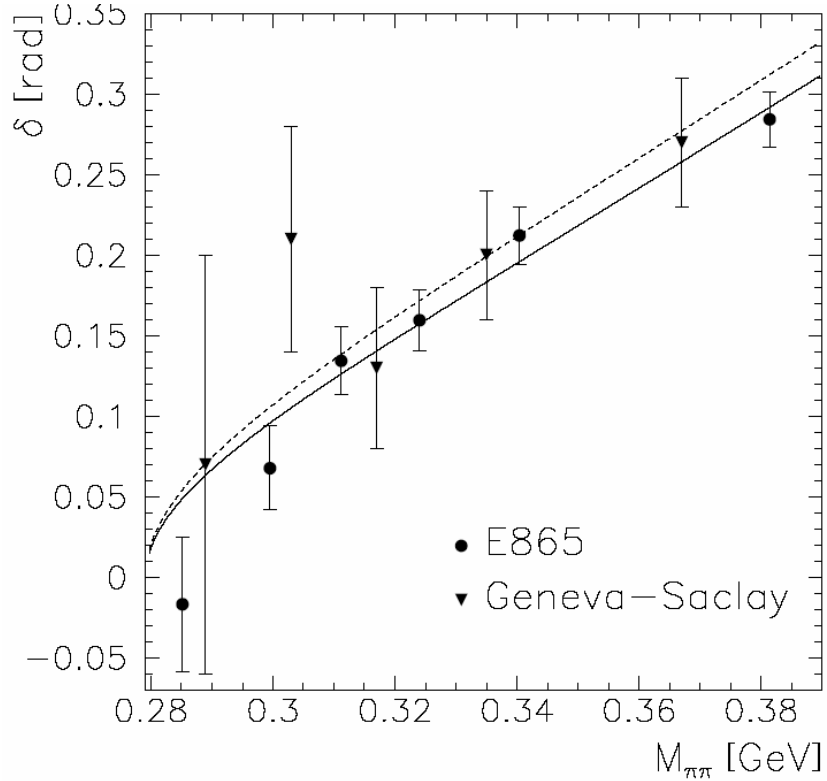
Statistics

- Decay distribution depends on 5 variables: large statistics needed

Kl4 decays

Statistics

- Geneva-Saclay (1977): 30k evts
- E865 (2001): 400k evts
- NA48 ….

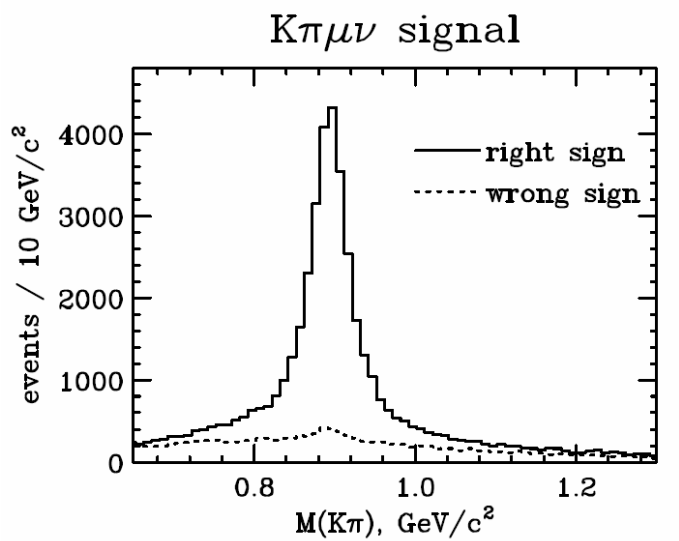


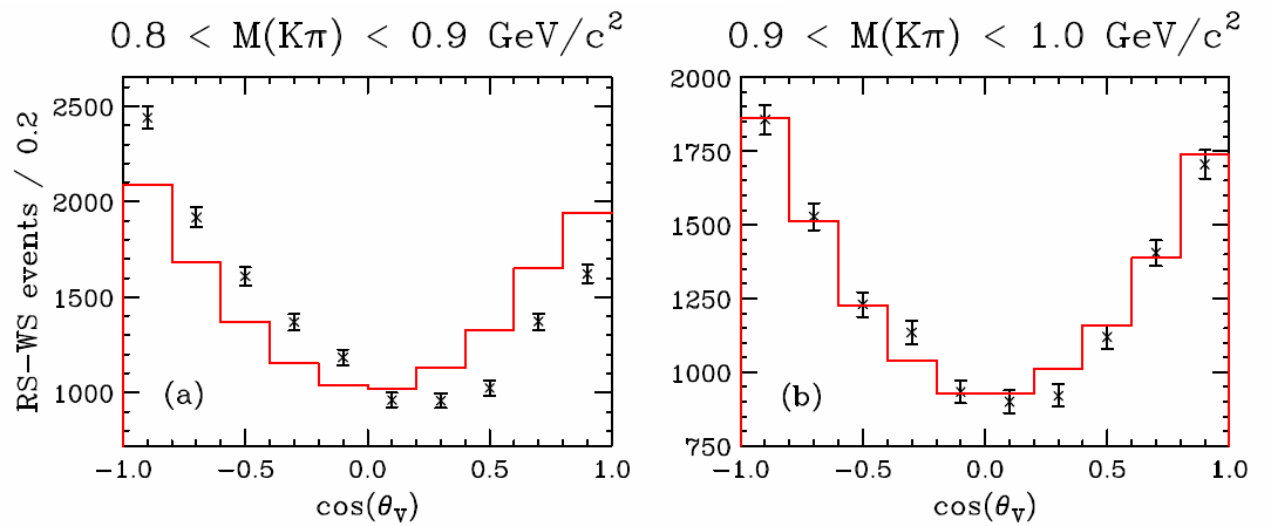
A sample of $4 \cdot 10^5$ events from the decay $K^+ \to \pi^+\pi^- e^+ \nu_e$ (K_{e4}) has been collected in experiment E865 at the Brookhaven AGS. The analysis of these data yields new measurements of the K_{e4} branching ratio ($(4.11 \pm 0.01 \pm 0.11) \cdot 10^{-5}$), the s-wave $\pi\pi$ scattering length ($a_0^0 = 0.228 \pm 0.012 \pm 0.003$), and the form factors F, G, and H of the hadronic current and their dependence on the invariant $\pi\pi$ mass.

Dl4 decays actual results

Experiment

- FOCUS: photo-production at FNAL (1996-1997)
- Channel: $D^+ \rightarrow K^-\pi^+\mu^+\nu$
- Statistics: 30k events





Conclusions

Expected statistics in BaBar

- Channel: $D^{*+} \rightarrow D^0\pi^+$, $D^0 \rightarrow K^0\pi^-e^+\nu$
- Channel: $D^{*+} \rightarrow D^0\pi^+$, $D^0 \rightarrow K^-\pi^0e^+\nu$
- Channel: $D^{*+} \rightarrow D^+\pi^0$, $D^+ \rightarrow K^-\pi^+e^+\nu$
- Statistics: >100k events
- Channel: $D^{*+}_s \rightarrow D^+_s\gamma$, $D^+_s \rightarrow K^-K^+e^+\nu$
- Channel: $D^+_s \rightarrow \varphi e^+\nu$

Expect clean measurements:

- δ_S-δ_P ($m_{K\pi}$)
- compare with chiral symmetry predictions
- m_s
- compare $F_i(q2)$ measurements with LQCD

….. difficult analyses …

….. data is there ….