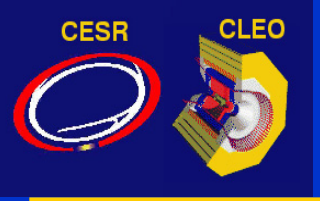
CLEO-c & CESR-c: A New Frontier in Weak & Strong Interactions

CLEO-c Collaboration:
Carleton, Carnegie Mellon, Chicago, Cornell, Florida, George Mason, Illinois, Kansas, Luther, Northwestern, Minnesota, Oklahoma, Pittsburgh, Puerto Rico, Purdue, Rochester, RPI, SMU, SUNY Albany, Syracuse, Vanderbilt, Wayne State.



CLEO-c: The Context

This Decade

Flavor Physics is now in "the sin2β era", akin to Weak Physics & "the precision Z era" in the '90s. B-factories will overconstrain CKM matrix with precision measurements. The discovery potential is limited by systematic errors from non-perturbative QCD.

The Future

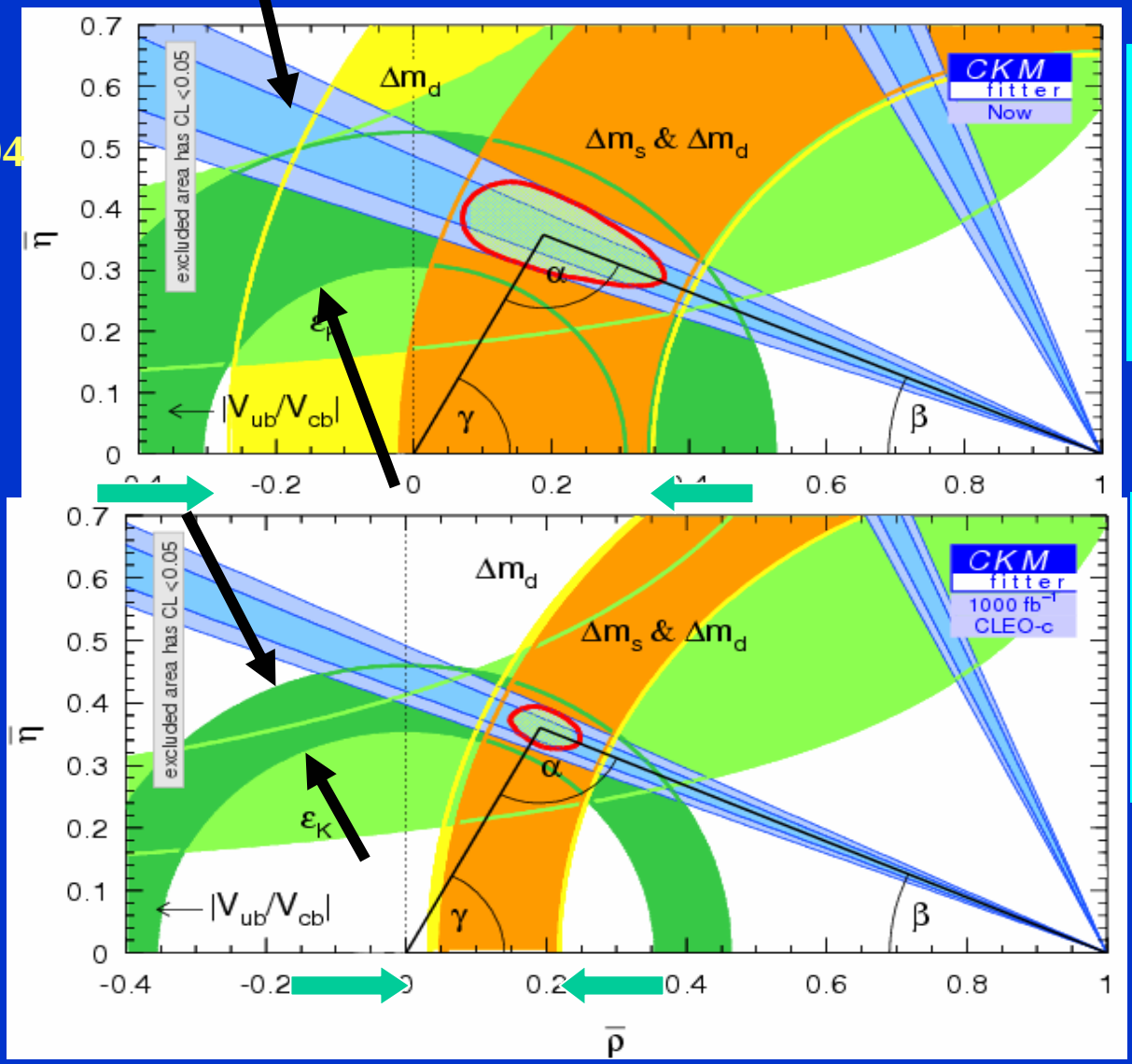
LHC may uncover strongly coupled sectors in the physics that lies beyond the Standard Model. The LC will study them. Strongly-coupled field theories are an outstanding challenge to theoretical physics. Critical need for reliable theoretical techniques & detailed data to calibrate them.

The Lattice is a complete definition of perturbative & non-perturbative QCD & therefore the premier example of a strongly coupled FT. In the next few years the expectation is for calculations at the few % level in B, D, ψ, & ϒ.

Charm at threshold can provide the data to test & calibrate QCD techniques such as the Lattice. Hence CLEO-c/CESR-c.

Precision theory + charm = dramatic increase in the potential of quark flavor physics to discover new physics

2004



Theoretical errors dominate width of bands

precision QCD calculations tested with *precision* charm data from CLEO-c
➔theory errors of a few % on B system decay constants & semileptonic form factors

+

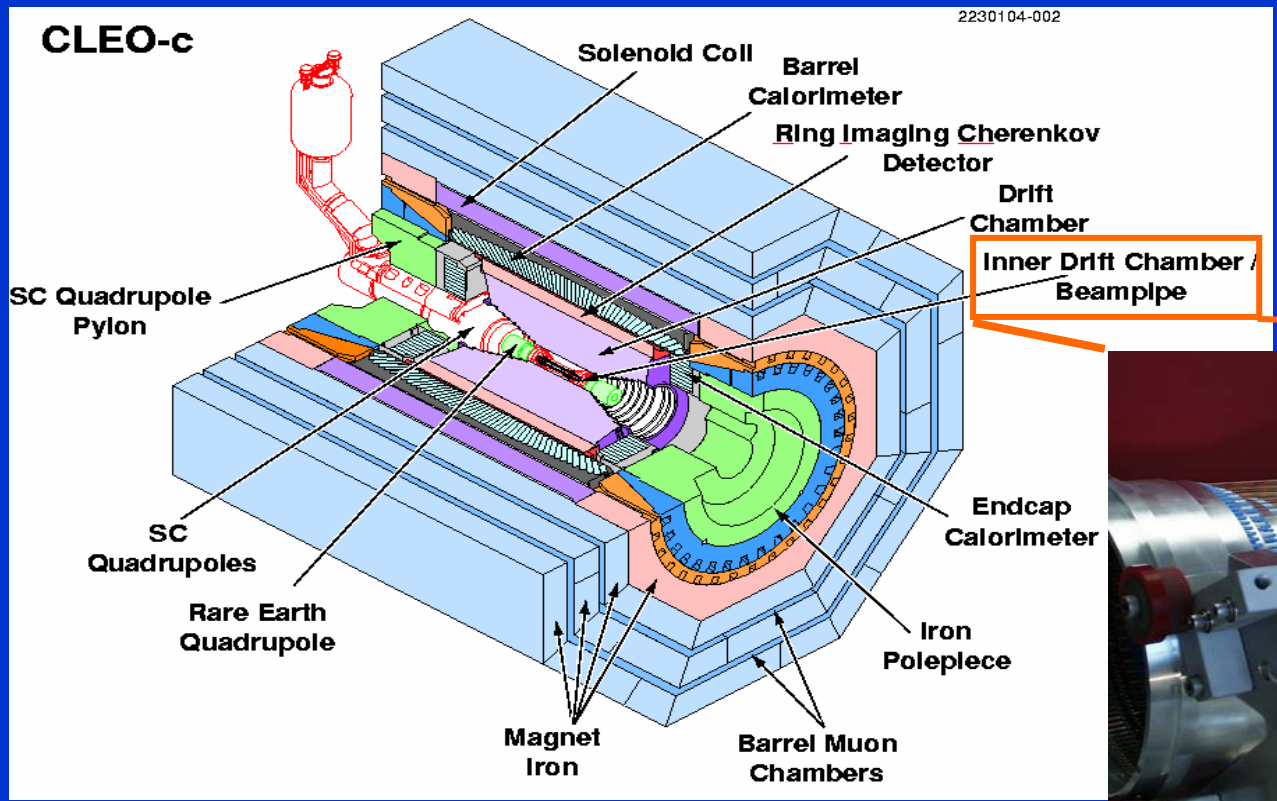
500 fb^{-1} @ BABAR/Belle

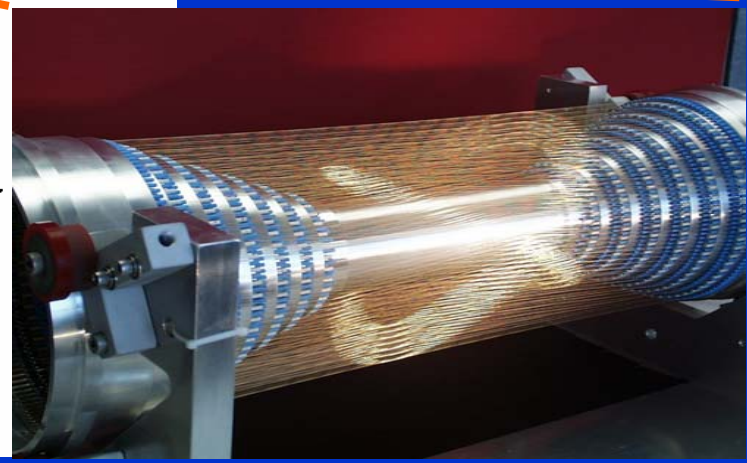
CLEO-c Physics Program

- Flavor Physics: overcome the hadronic road block
  - Precision charm absolute branching ratio msmts needed for precision B msmts… can be the limiting systematic error
- Tests QCD techniques in c-sector…
  - decay constants, form factors, V_{cs}, V_{cd}, unitarity
- … And apply to b-sector
  - Precision V_{ub}, V_{cb}, V_{td}, & V_{ts}
  - Maximizes sensitivity to new physics
- Lattice testing ground
  - Precise measurements of quarkonia spectroscopy & decay
- Physics beyond the Standard Model
  - D-mixing, CPV, rare decays, + measure strong phases
- The CLEO-c program will enable this decade's flavor physics & the next decade's new physics

Detector: CLEO III → CLEO-c

- **Minor modifications:**
  - Silicon → 6-layer low mass inner drift chamber
  - B-field: 1.5T→1.0T

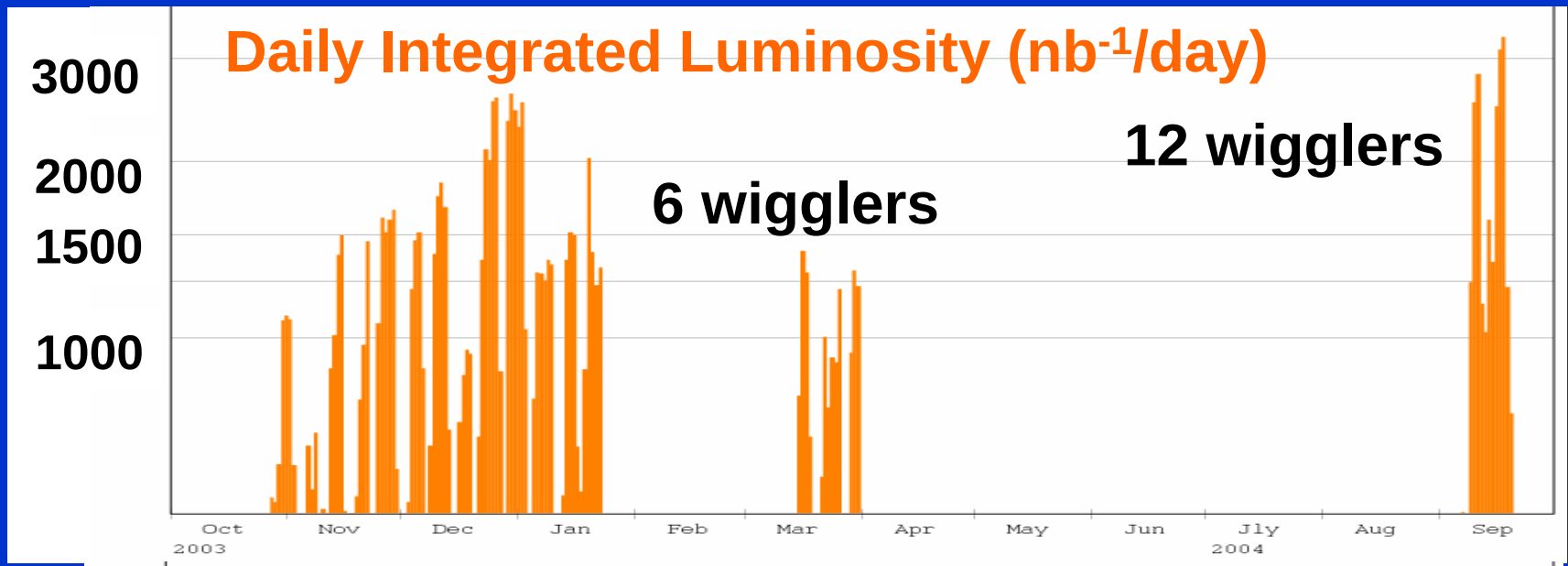


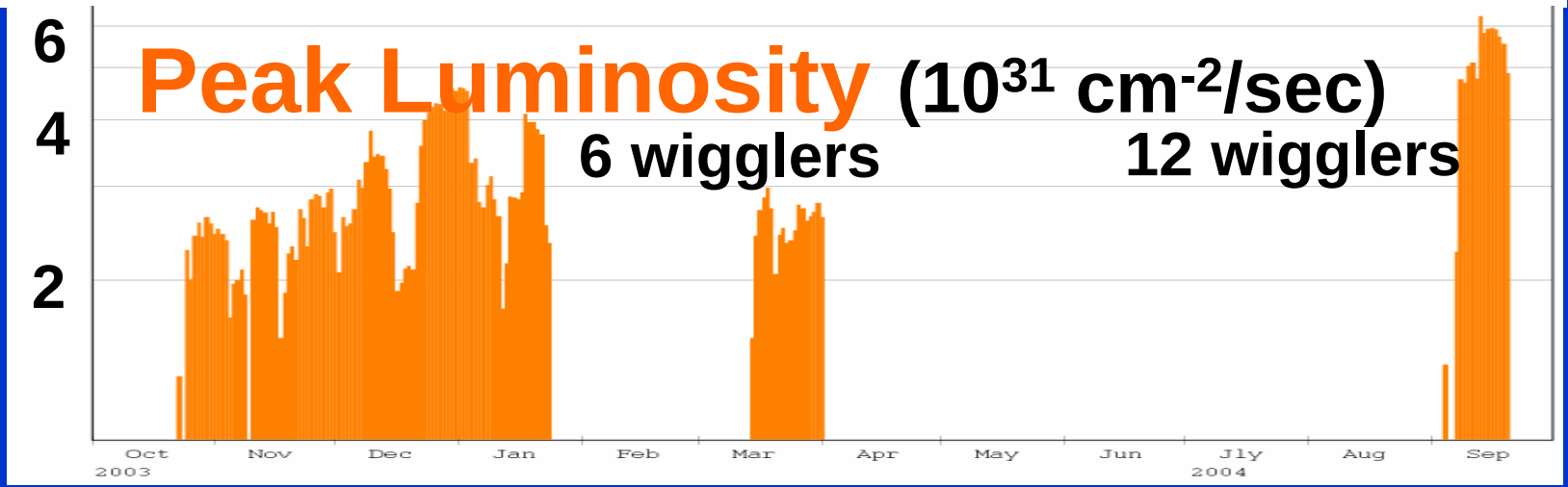


Status

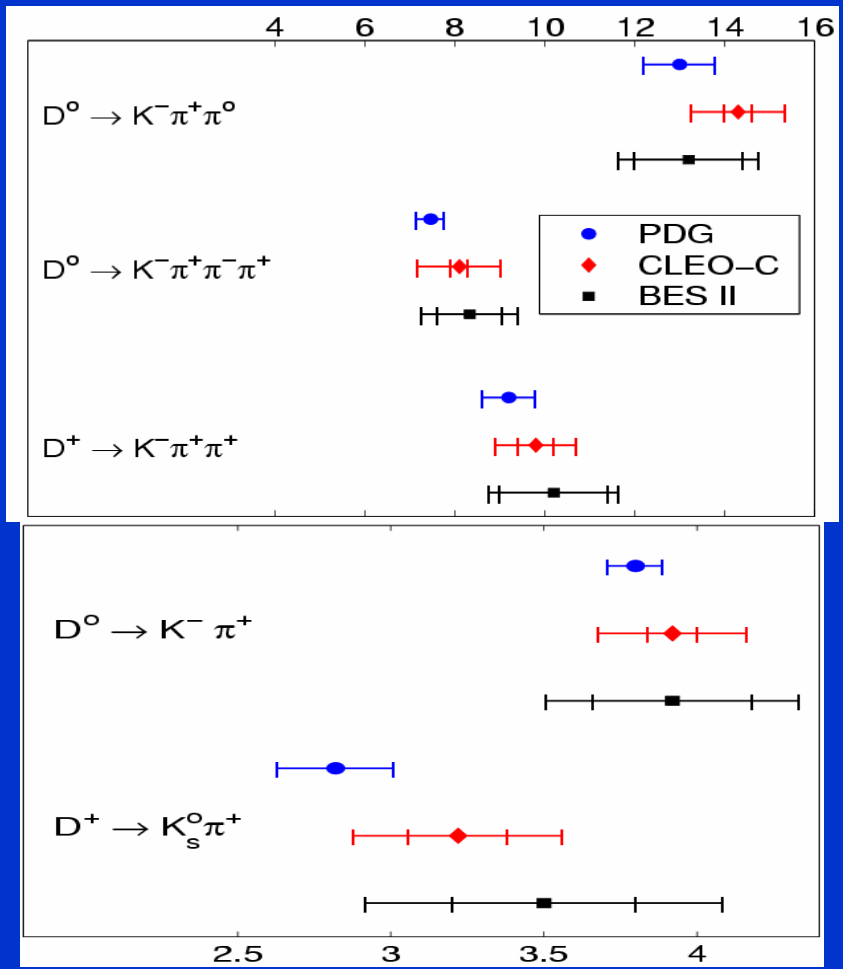
- CESR upgraded to CESR-c
  - 12 wigglers for damping
    - 6 installed in summer '03, 6 installed summer '04
  - Luminosity tuning monitor (high rate) installed
  - ~50% time commitment to CHESS (Cornell High Energy Synchrotron Source) @ ~5 GeV
    - No more simultaneous CLEO/CHESS running
- Sept '03-Mar '04
  - 6-wiggler Pilot Run
  - $L_{PEAK} = 4.6 \times 10^{31}$
  - 57 pb^{-1} @ $\psi(3770)$ (6×Mark III, 3×BES II)
  - 5.5 pb^{-1} @ $\psi(2S)$ (3686)
  - 20 pb^{-1} @ 3670 (continuum just below $\psi(2S)$)
- Preliminary results at ICHEP on many high priority topics (as well as "niche" physics like quarkonia decays)

Luminosity: Going up…





D-hadronic BRs



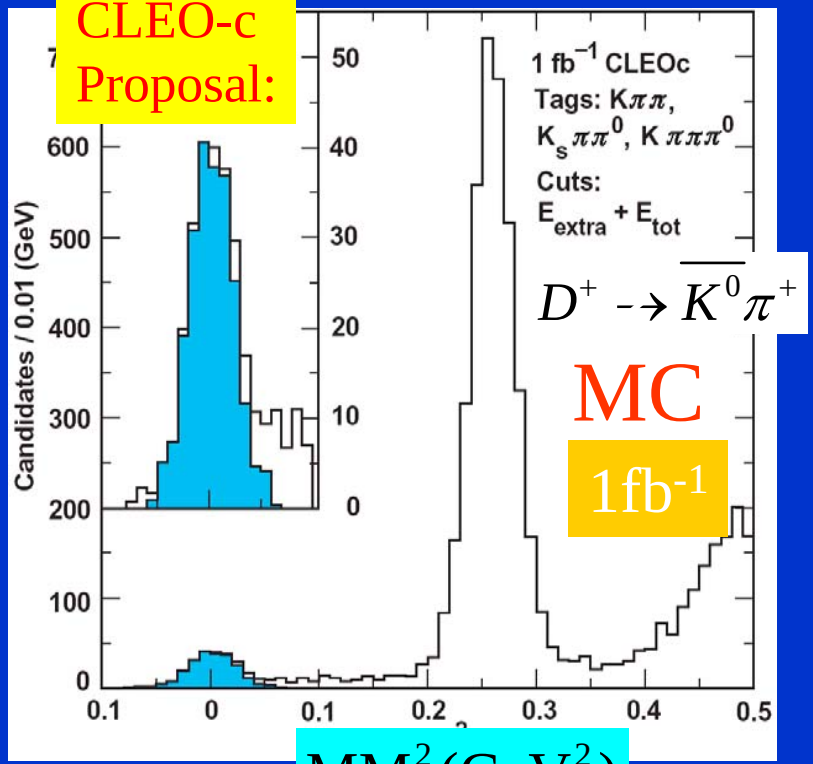
$\sigma(DD)=(6.06\pm0.13\pm0.23)$ nb

f_{D^+} from Absolute Br($D^+ \to \mu^+\nu$)

Hadronic tag $\leftarrow D^-$ $D^+ \to \mu^+\nu$ 1 track, μ consistent, no showers

$$MM^2 = (E_{beam} - E_\mu)^2 - (-\overrightarrow{P_{Dtag^+}} - \overrightarrow{P_\mu})^2$$

CLEO-c Proposal:



f_{D^+} from Absolute Br($D^+ \to \mu^+\nu$)

hep-ex/0408071
(Preliminary)

Tags 28575

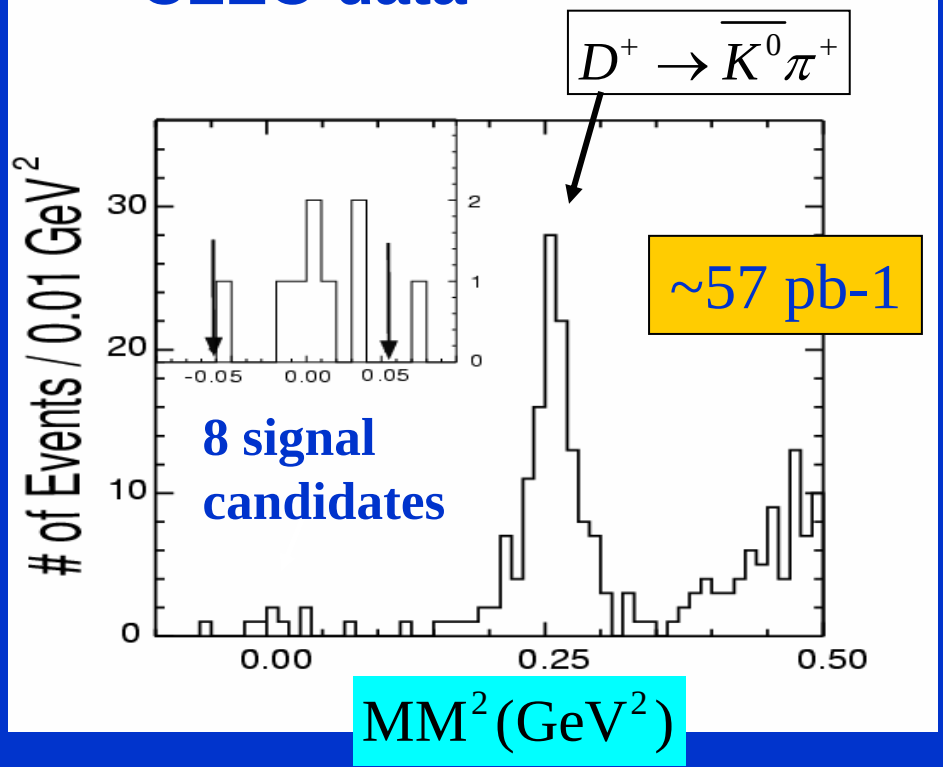
Signal 8 events

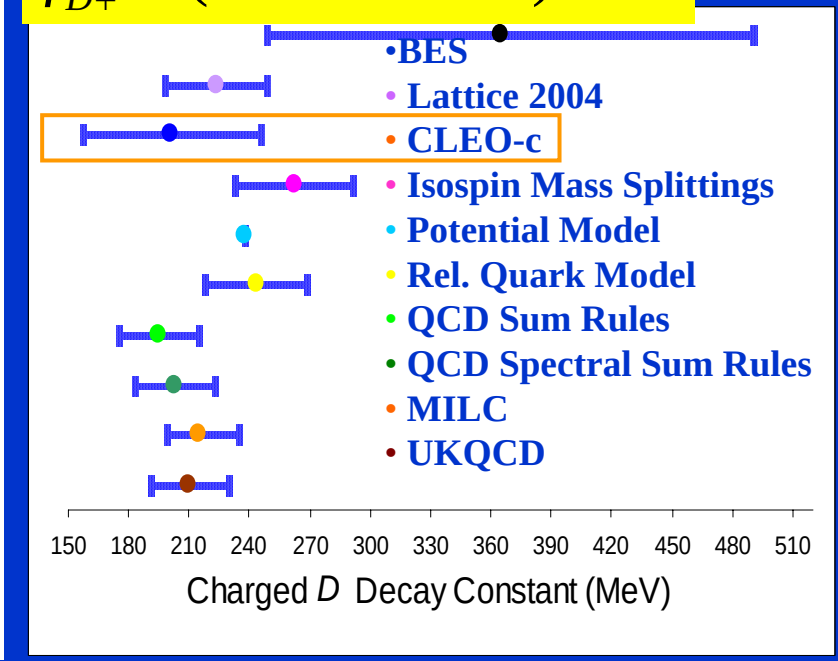
Bkgd 1.07 ± 1.07

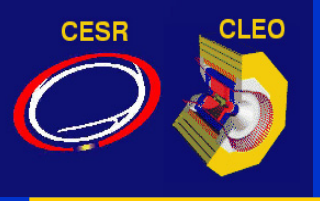
$B = (3.5 \pm 1.4 \pm 0.6) \times 10^{-4}$

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

CLEO data







Run Plan

- CESR-c
  - Components in place, including fast luminosity tuning monitor
  - Improvements seen already. Factor of ~5 to design performance.
- Big Picture: Now – 2007
  - "Yellow Book" priorities have not changed
  - Year 1: D physics : 3 fb^{-1} @ $\psi(3770)$
  - Year 2: D_S physics: 3 fb^{-1} @ ~4140: $D_S D_S$ threshold
  - Year 3: QCD w/10^9 J/ψ (20×BES)
- Other c.m. energies potentially of interest…
  - Will be taken so as to not compromise above goals
  - $\psi(2S)$
    - Physics: h_c studies, 12% rule, η_c BRs, J/ψ BRs, …
    - Even in small doses, useful for calibration, systematic checks
  - Continuum @ 3670
  - R scan
  - 3770 scan
  - ??
- Exciting years ahead!