Hadronic Moments in Semileptonic B Decays from CDFII

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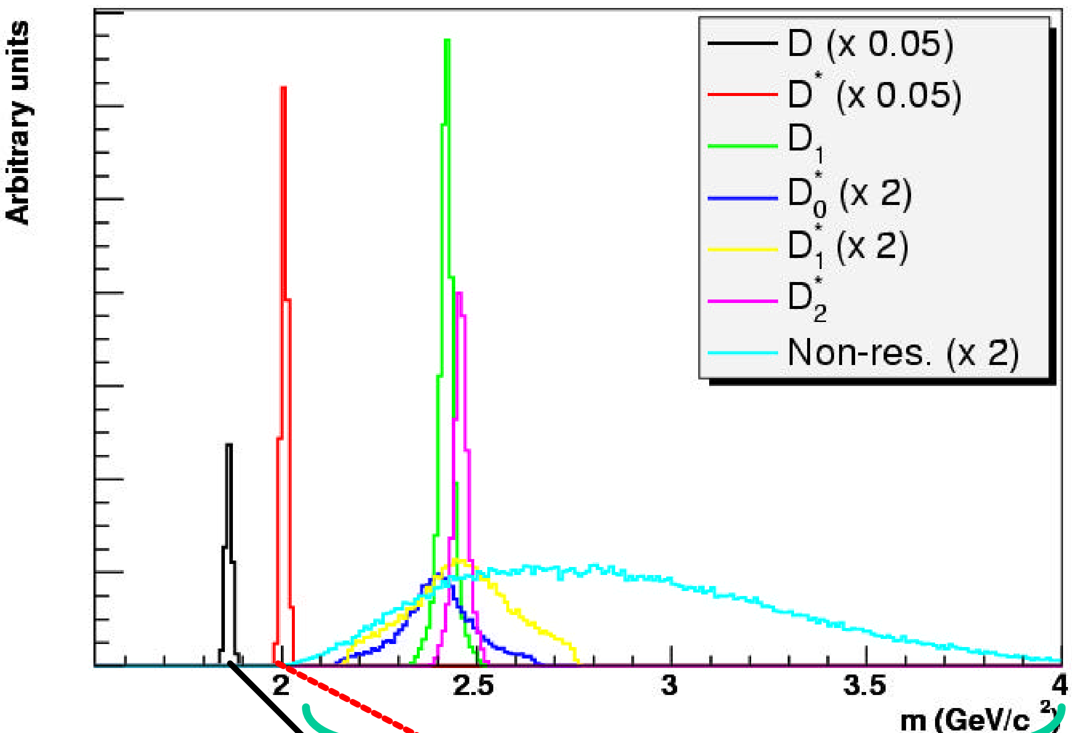
Analysis Strategy

Typical mass spectrum $M(X^0_c)$ (Monte Carlo):



D^0 and D^{*0} well-known
➔ measure only f**
➔ only shape needed

1) Measure $f^{**}(s_H)$
2) Correct for background, acceptances, bias
➔ moments of D**
3) Add D and D* ➔ M_1,M_2
4) Extract L, l_1

$$s_H \equiv M^2_{X_c}\Big|$$

$$\frac{1}{\Gamma_{sl}}\frac{d\Gamma_{sl}}{ds_H} = \frac{\Gamma_0}{\Gamma_{sl}}\cdot\delta(s_H - m^2_{D^0}) + \frac{\Gamma_*}{\Gamma_{sl}}\cdot\delta(s_H - m^2_{D^{*0}}) + \left(1 - \frac{\Gamma_0}{\Gamma_{sl}} - \frac{\Gamma_*}{\Gamma_{sl}}\right)\cdot f^{**}(s_H)$$

Channels

Possible D'→$D^{(*)}\pi\pi$ contributions neglected:

- No B→lD' experimental evidence so far
- DELPHI limit: $$\begin{cases} BR\left(b \to D^{+}\pi^{+}\pi^{-}\ell^{-}\nu\right) < 0.18\% \ @\ 90\%\ CL \\ BR\left(b \to D^{*+}\pi^{+}\pi^{-}\ell^{-}\nu\right) < 0.17\% \ @\ 90\%\ CL \end{cases}$$

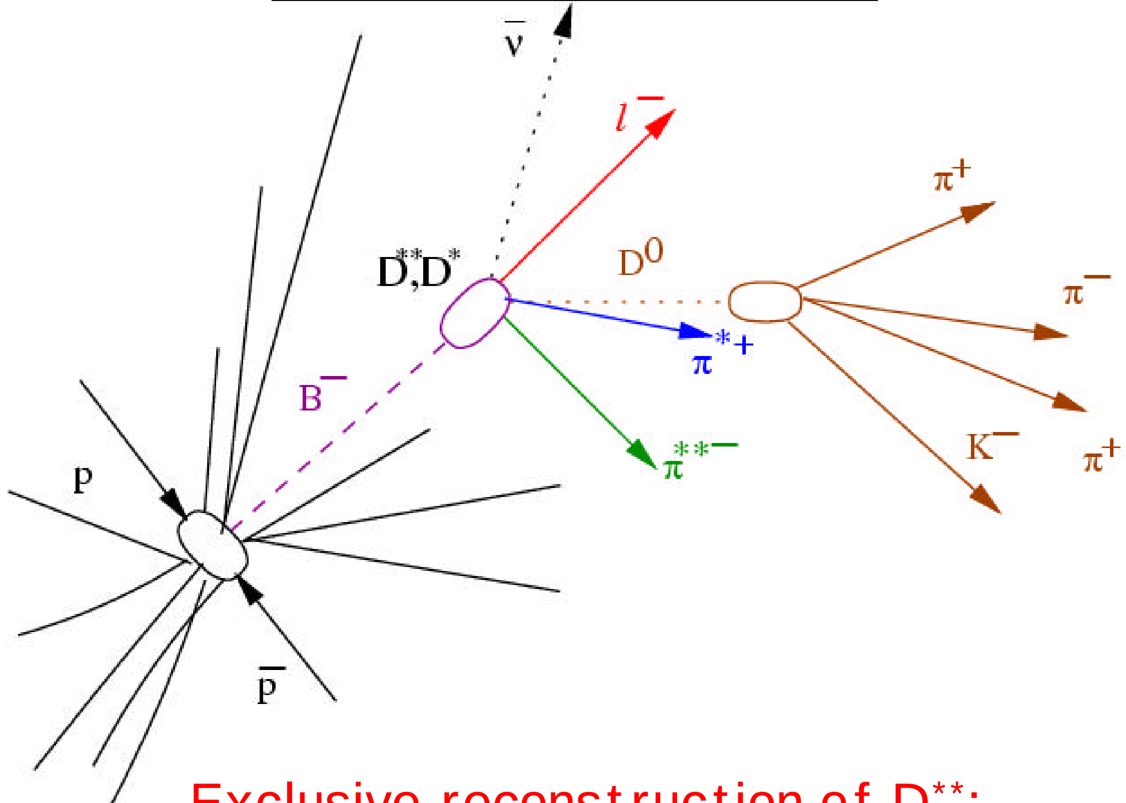
We assume no D' contribution in our sample

Must reconstruct all channels to get all the D^{**} states.

→ However CDF has limited capability for neutrals

- $B^0 \to D^{**-} l^+ \nu$ always leads to neutral particles → ignore it
- $B^- \to D^{**0} l^- \nu$ better, use isospin for missing channels:
  - $D^{**0} \to D^+\pi^-$ OK
  - $D^{**0} \to D^0\pi^0$ Not reconstructed. Half the rate of $D^+\pi^-$
  - $D^{**0} \to D^{*+}\pi^-$
    - $D^{*+} \to D^0\pi^+$ OK
    - $D^{*+} \to D^+\pi^0$ Not reconstructed. Feed-down to $D^+\pi^-$
  - $D^{**0} \to D^{*0}\pi^0$ Not reconstructed. Half the rate of $D^{*+}\pi^-$

Event Topology



Exclusive reconstruction of D^{**}:

$D^{**0} \Rightarrow D^+ \pi^{**-}$

↳ $K^- \pi^+ \pi^+$ (Br=9.2%)

"D^+"

$D^{**0} \Rightarrow D^{*+} \pi^{**-}$

↳ $D^0 \pi^{*+}$ (Br=67.7%)

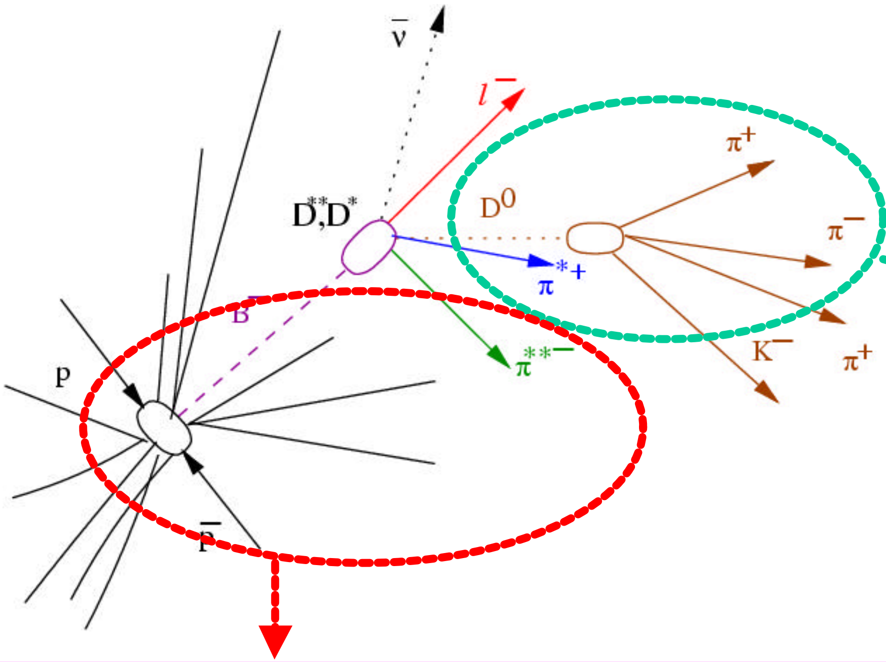
↳ $K^- \pi^+$ (Br=3.8%)

↳ $K^- \pi^+ \pi^- \pi^+$ (Br=7.5%)

↳ $K^- \pi^+ \pi^0$ (Br=13.0%)

"D^{*+}"

Backgrounds



Physics background:
$B \rightarrow D^{(*)+} D_s^-$, $D_{(s)} \rightarrow X l \nu$
➔ MC, subtracted

Combinatorial background under the $D^{(*)}$ peaks:
➔ sideband subtraction

Prompt pions faking π^{**}:
- fragmentation
- underlying event

➔separate B and primary vertices
(kills also prompt charm)
➔ use impact parameters to discriminate
➔ model: wrong-sign $\pi^{**+} \ell^-$ combinations

Feed-down in signal:
$D^{**0} \rightarrow D^{*+}(\rightarrow D^+ \pi^0) \pi^-$
irreducible background to
$D^{**0} \rightarrow D^+ \pi^-$.
➔subtracted using data:
➔shape from $D^0 \pi^-$ in
$D^{**0} \rightarrow D^{*+}(\rightarrow D^0 \pi^+) \pi^-$
➔rate:
½ (isospin) x eff. x BR

Lepton + D Reconstruction

Total: ~ 28000 events

Data Sample:

- e/μ + displaced track
- ~ 180 pb^{-1}

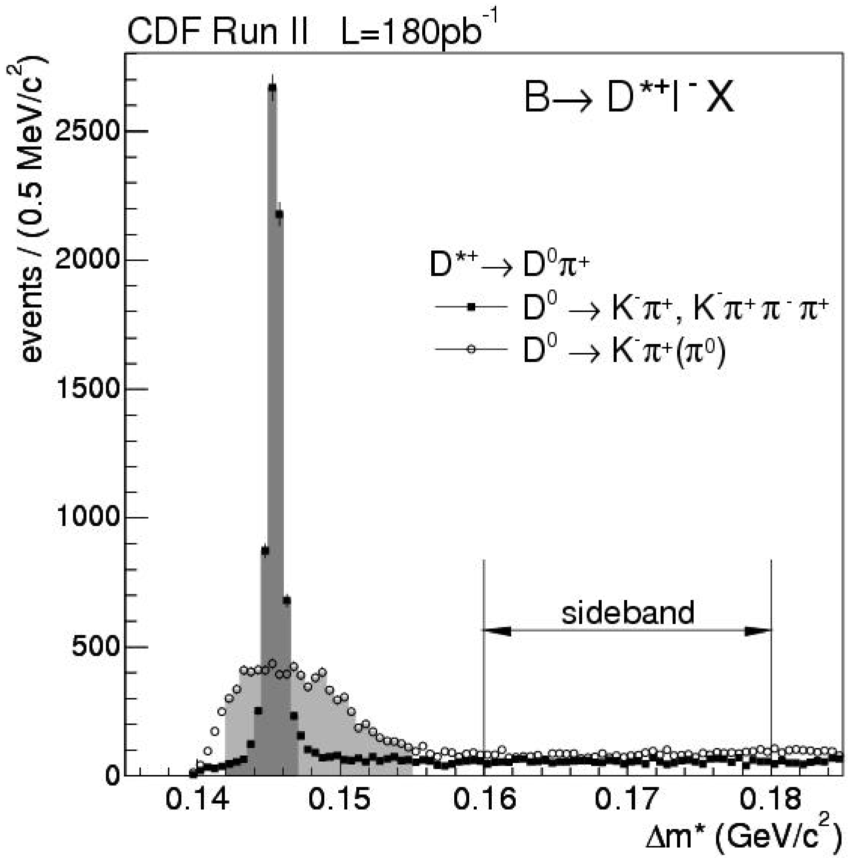
(→ Sept 2003)

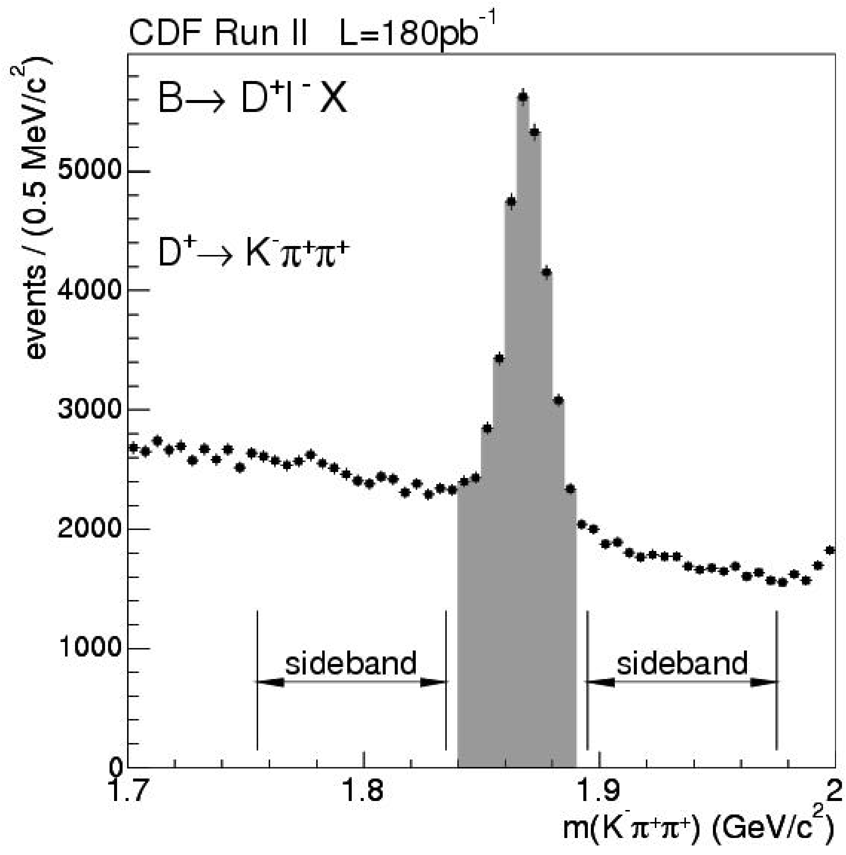
Track Selection:

- 2 GeV track (SVT leg)
- e/μ: $p_T > 4$ GeV
- other: $p_T > 0.4$ GeV

Lepton + $D^{(*)+}$:

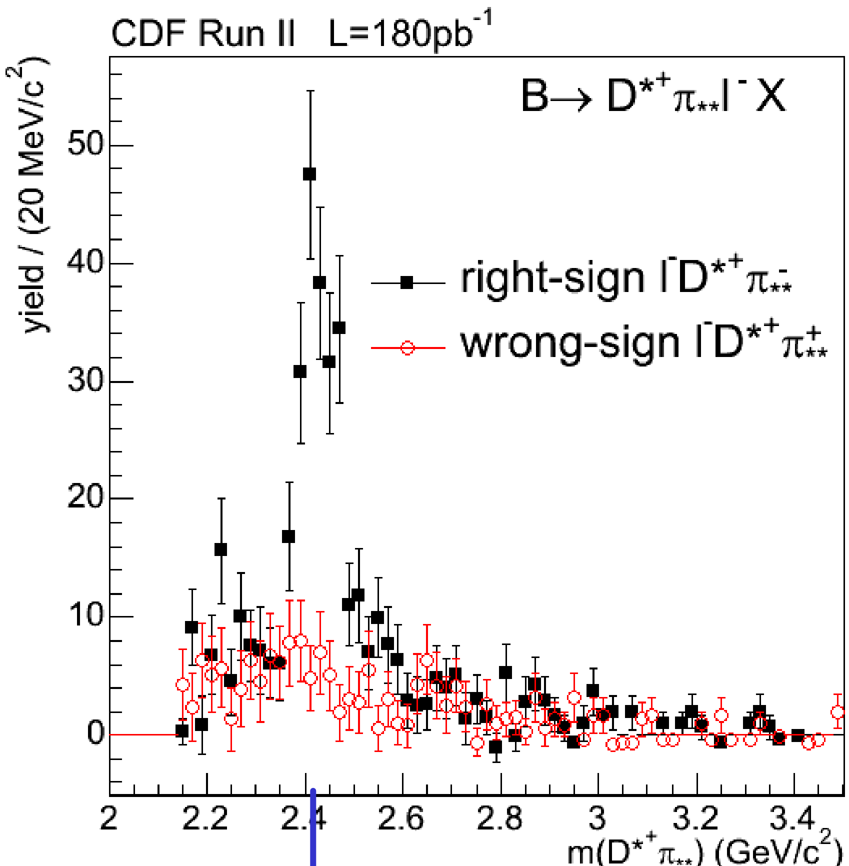
- D vertex:
  - 3D
- l+D(+π_*) vertex ("B"):
  - 3D
  - $L_{xy}(B) > 500$ μm
  - m(B) < 5.3 GeV

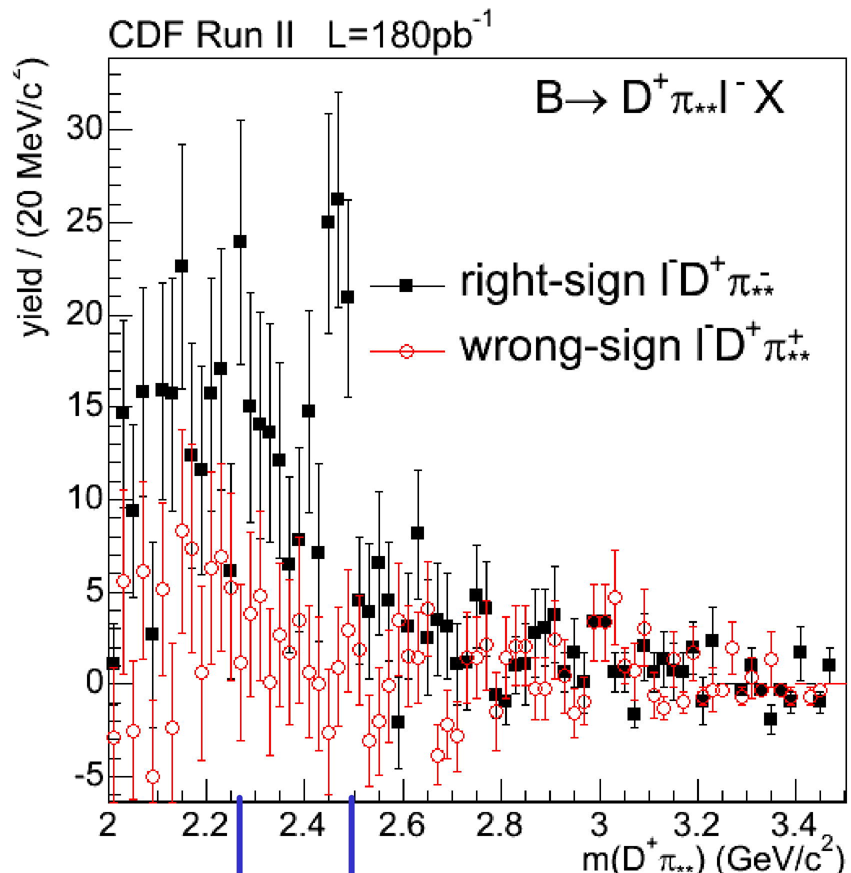




Raw m** Distributions

Measured in Δm^{**}, shifted by $M(D^{(*)+})$, side-band subtracted.





D_1, D_1^*, D_2^*

Feed-down

D_2^*, D_0^*

Efficiency Corrections

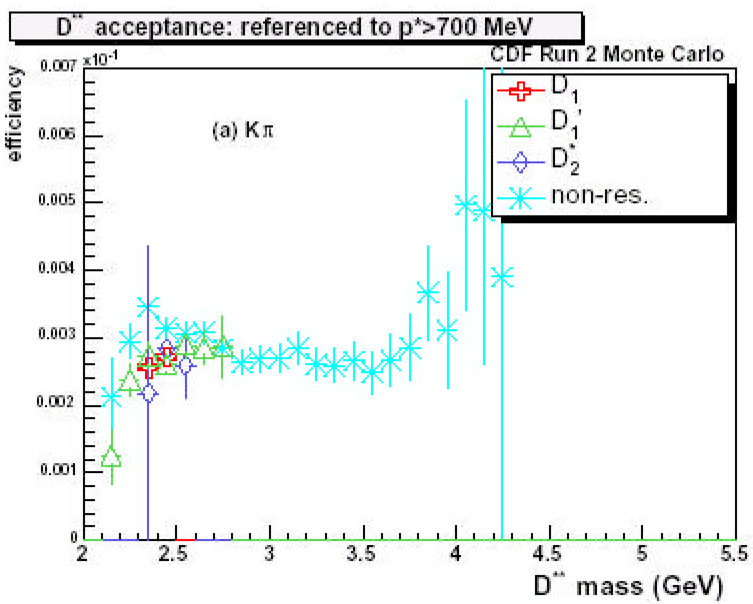
1) Correct the raw mass for any dependence of ε_{reco} on M(D**):

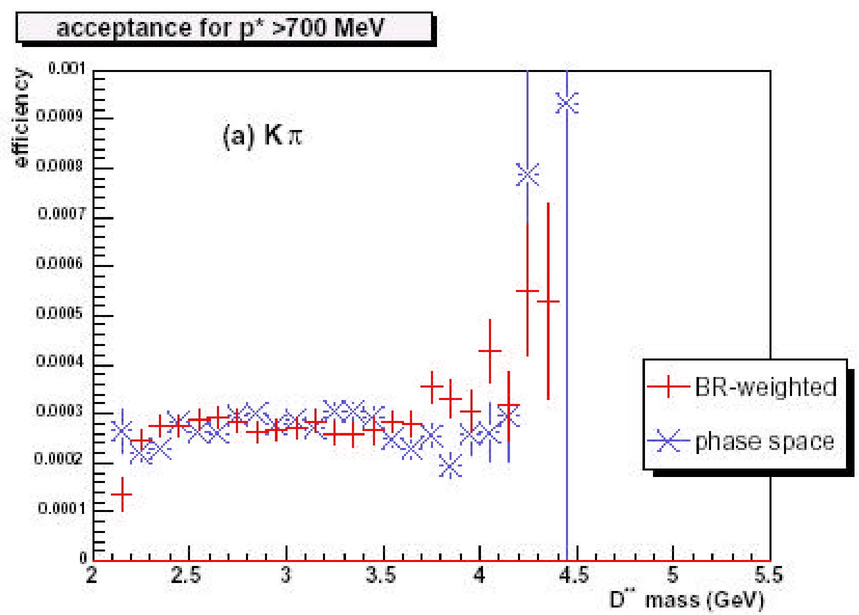
- Possible dependence on the D** species (spin).
- Monte-Carlo for all D** (Goity-Roberts for non-resonant), cross-checked with pure phase space decays.
- Detector simulation shortcomings cause residual data/MC discrepancy: derive corrections from control samples (D* and D daughters)

2) Cut on lepton energy in B rest frame:

- Theoretical predictions need well-defined p_l* cut.
- We can't measure p_l*, but we can correct our measurement to a given cut:

➔ p_l* > 700 MeV/c.



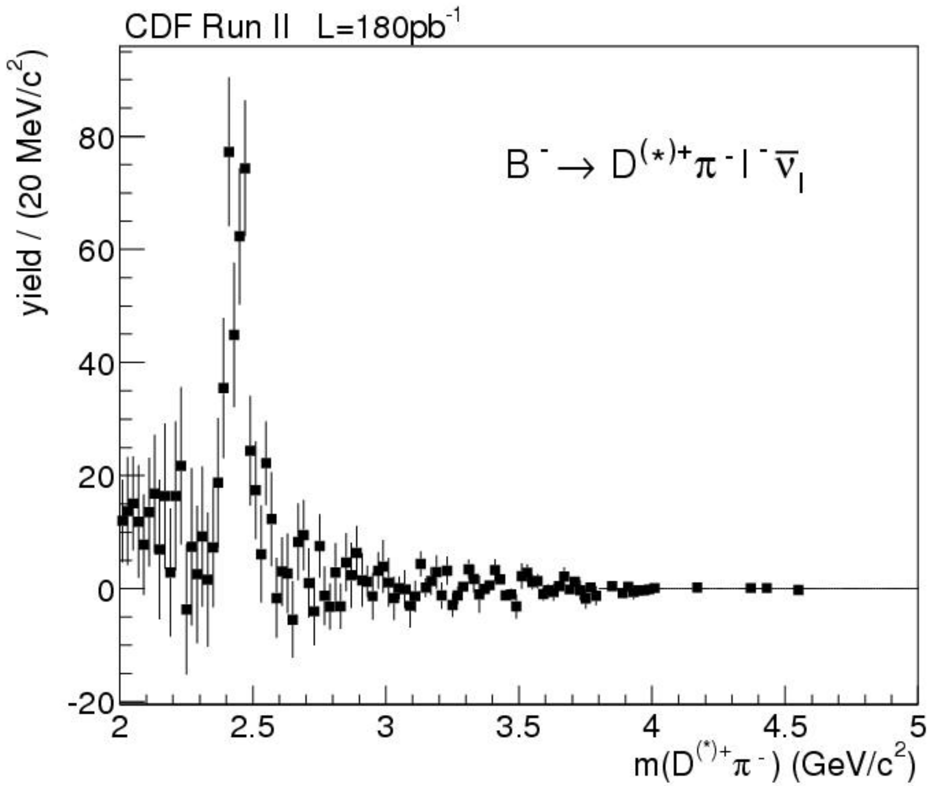


Corrected Mass and D** Moments

Procedure:

- Unbinned procedure using weighted events.
- Assign negative weights to background samples.
- Propagate efficiency corrections to weights.
- Take care of the D^+ / D^{*+} relative normalization.
- Compute mean and sigma of distribution.

Results (in paper):



$$m_1 = \left\langle m^2_{D^{**}} \right\rangle = \left(5.83 \pm 0.16_{stat}\right) GeV^2$$

$$m_2 = \left\langle \left(m^2_{D^{**}} - m_1\right)^2 \right\rangle = \left(1.30 \pm 0.69_{stat}\right) GeV^4$$

No Fit !!!

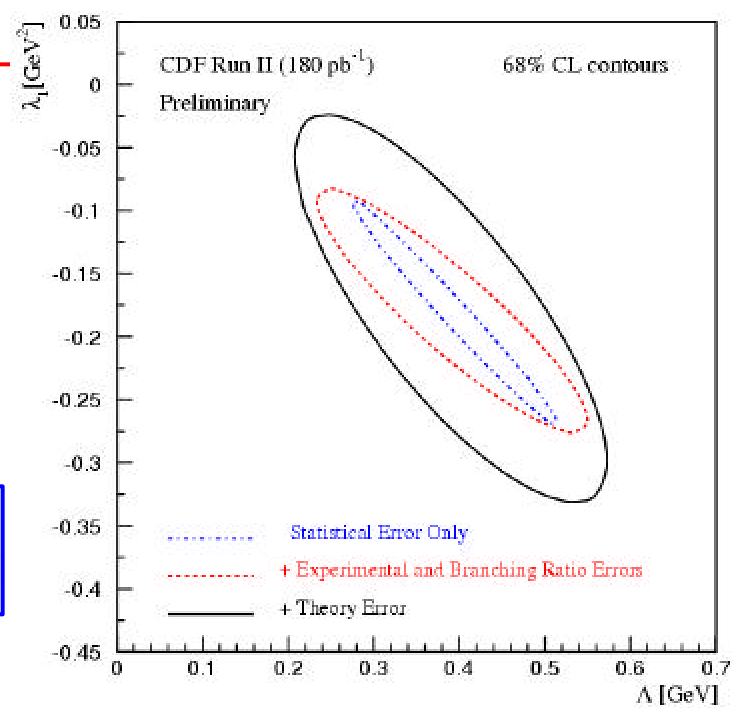
Final Results

$$m_1 \equiv \left\langle m^2_{D^{**}} \right\rangle = (5.83 \pm 0.16_{\text{stat}} \pm 0.08_{\text{syst}}) \;\; \text{GeV}^2$$
$$m_2 \equiv \left\langle \left(m^2_{D^{**}} - \left\langle m^2_{D^{**}} \right\rangle \right)^2 \right\rangle = (1.30 \pm 0.69_{\text{stat}} \pm 0.22_{\text{syst}}) \;\; \text{GeV}^4$$

$\rho(m_1,m_2)=0.61$

$$M_1 \equiv \langle s_H \rangle - m^2_{\bar{D}} = (0.467 \pm 0.038_{\text{stat}} \pm 0.019_{\text{exp}} \pm 0.065_{\text{BR}}) \;\; \text{GeV}^2$$
$$M_2 \equiv \left\langle (s_H - \langle s_H \rangle)^2 \right\rangle = (1.05 \pm 0.26_{\text{stat}} \pm 0.08_{\text{exp}} \pm 0.10_{\text{BR}}) \;\; \text{GeV}^4 \;\; ,$$

$\rho(M_1,M_2)=0.69$



Pole mass scheme

$$\Lambda = (0.397 \pm 0.078_{\text{stat}} \pm 0.027_{\text{exp}} \pm 0.064_{\text{BR}} \pm 0.058_{\text{theo}}) \;\; \text{GeV}$$
$$\lambda_1 = (-0.184 \pm 0.057_{\text{stat}} \pm 0.017_{\text{exp}} \pm 0.022_{\text{BR}} \pm 0.077_{\text{theo}}) \;\; \text{GeV}^2$$

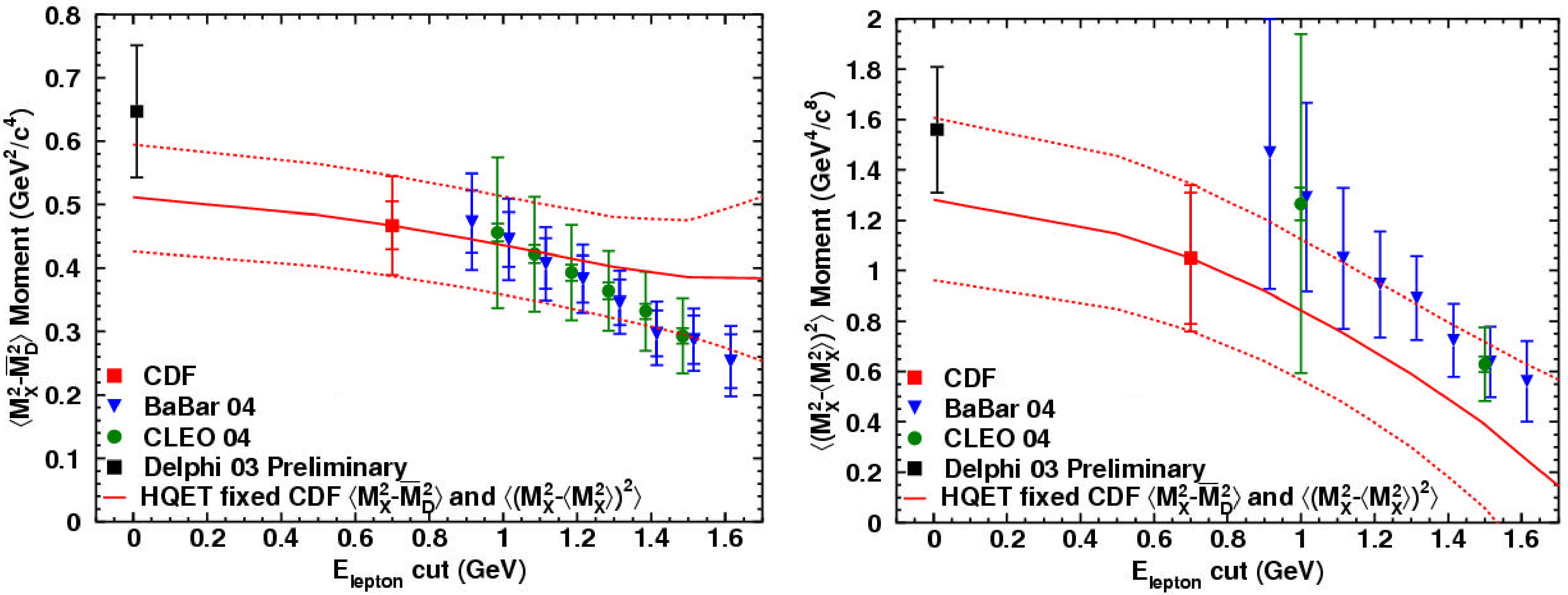
1S mass scheme

$$m_b^{1S} = (4.654 \pm 0.078_{\text{stat}} \pm 0.027_{\text{exp}} \pm 0.064_{\text{BR}} \pm 0.089_{\text{theo}}) \;\; \text{GeV}$$
$$\lambda_1^{1S} = (-0.277 \pm 0.049_{\text{stat}} \pm 0.017_{\text{exp}} \pm 0.022_{\text{BR}} \pm 0.094_{\text{theo}}) \;\; \text{GeV}^2$$

Systematic Errors (from the paper)

	Δm_1 (GeV^2)	Δm_2 (GeV^4)	ΔM_1 (GeV^2)	ΔM_2 (GeV^4)	$\Delta\Lambda$ (GeV)	$\Delta\lambda_1$ (GeV^2)
Stat.	0.16	0.69	0.038	0.26	0.078	0.057
Syst.	0.08	0.22	0.068	0.13	0.091	0.082
Mass resolution	0.02	0.13	0.005	0.04	0.012	0.009
Eff. Corr. (data)	0.03	0.13	0.006	0.05	0.014	0.011
Eff. Corr. (MC)	0.06	0.05	0.016	0.03	0.017	0.006
Bkgd. (scale)	0.01	0.03	0.002	0.01	0.003	0.002
Bkgd. (opt. Bias)	0.02	0.10	0.004	0.03	0.006	0.006
Physics bkgd.	0.01	0.02	0.002	0.01	0.004	0.002
D^+ / D^{*+} BR	0.01	0.02	0.002	0.01	0.004	0.002
D^+ / D^{*+} Eff.	0.02	0.03	0.004	0.01	0.005	0.002
Semileptonic BRs			0.065	0.10	0.064	0.022
ρ_1					0.041	0.069
T_i					0.032	0.031
α_s					0.018	0.007
m_b, m_c					0.001	0.008
Choice of p_l^* cut					0.019	0.009

Comparison with Other Measurements



Pole mass scheme

Summary

- First measurement at hadron machines: different environment and experimental techniques.
- Competitive with other experiments. Little model dependency. No assumptions on shape or rate of D** components.
- Through integration with other experiments and other "moments" we can seriously probe HQET/QHD
- Let's do it!

BACK-UP SLIDES

Motivation (I)

Most precise determination of V_{cb} comes from Γ_{sl} (“inclusive” determination):

$$\Gamma_{sl}(b \to c\ell^- \overline{n}) = \frac{BR(b \to c\ell^- \overline{n}_\ell)}{t_b} = |V_{cb}|^2 \times F_{theory}$$

Υ(4S), LEP/SLD, CDF measurements. Experimental $\Delta|V_{cb}|$~1%

Theory with pert. and non-pert. corrections. $\Delta|V_{cb}|$~2.5%

F_{theory} evaluated using OPE in HQET: expansion in α_s and $1/m_B$ powers:

$O(1/m_B)$ $\to$ 1 parameter: Λ

(Bauer et al., PRD 67 (2003) 071301)

$O(1/m_B^2)$ $\to$ 2 more parameters: λ_1, λ_2

$O(1/m_B^3)$ $\to$ 6 more parameters: $\rho_1, \rho_2, T_{1\text{-}4}$

Constrained from pseudo-scalar/vector B and D mass differences

$$G_{sl} = \frac{G_F^2|V_{cb}|^2}{192p^3} m_B^5 c_1 \left\{1 - c_2\frac{a_s}{p} + \frac{c_3}{m_B}?(1 - c_4\frac{a_s}{p}) + \frac{c_5}{m_B^2}(?^2 + c_6 ?_1 + c_7 ?_2) + O(\frac{1}{m_B^3}) + O(\frac{a_s^2}{p}) \cdots\right\}$$

Motivation (II)

Many inclusive observables can be written using the same expansion (same non-perturbative parameters). The spectral moments:

- Photonic moments: Photon energy in $b \rightarrow s\,\gamma$ (CLEO)
- Leptonic moments: $B \rightarrow X_c l \nu$, lepton E in B rest frame (CLEO, DELPHI, BABAR)
- Hadronic moments: $B \rightarrow X_c l \nu$, recoil mass $M(X_c)$ (CLEO, DELPHI, BABAR, CDFII)

$$M_1 = \int_{s_H^{min}}^{s_H^{max}} ds_H \left(s_H - \overline{m}_D^2\right) \frac{1}{\Gamma_{sl}} \frac{d\Gamma_{sl}}{ds_H} = \langle s_H \rangle - \overline{m}_D^2 \,, \qquad s_H \equiv M_{X_c}^2$$

$$M_2 = \int_{s_H^{min}}^{s_H^{max}} ds_H \left(s_H - \langle s_H \rangle\right)^2 \frac{1}{\Gamma_{sl}} \frac{d\Gamma_{sl}}{ds_H} = \left\langle \left(s_H - \overline{m}_D^2\right)^2 \right\rangle - M_1^2$$

Constrain the unknown non-pert. parameters and reduce $|V_{cb}|$ uncertainty.

With enough measurements: test of underlying assumptions (duality…).

What is X_c?

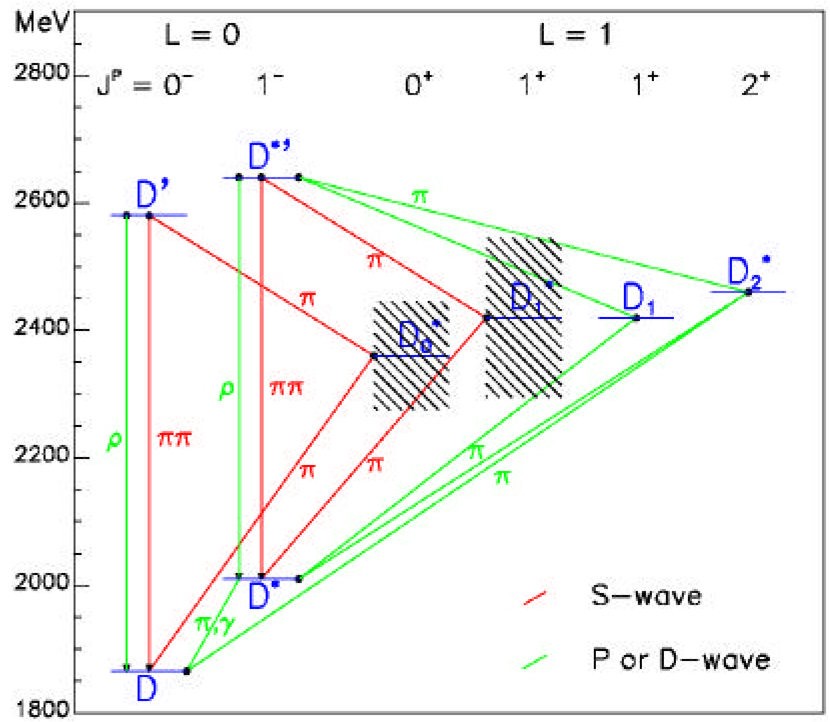
Semi-leptonic widths (PDG 04):

	Br (%)
$B^+ \rightarrow X_c$ l n	10.99 ± 0.31
$B^+ \rightarrow D^*$ l n	6.04 ± 0.23
$B^+ \rightarrow D$ l n	2.23 ± 0.15

(PDG b/B^+/B^0 combination, b→u subtracted)

➔~25% of semi-leptonic width is poorly known

Higher mass states: D**



Possible D'→D$^{(*)}\pi\pi$ contributions neglected:

- No B→lD' experimental evidence so far
- DELPHI limit: $\begin{cases} BR\left(b \rightarrow D^{+}p^{+}p^{-}\ell^{-}n\right) < 0.18\% \text{ @ } 90\% \ CL \\ BR\left(b \rightarrow D^{*+}p^{+}p^{-}\ell^{-}n\right) < 0.17\% \text{ @ } 90\% \ CL \end{cases}$

We assume no D' contribution in our sample

Combination with D^0, D^{*0}

$$\frac{1}{\Gamma_{sl}}\frac{d\Gamma_{sl}}{ds_H} = \frac{\Gamma_0}{\Gamma_{sl}}\cdot\delta(s_H - m^2_{D^0}) + \frac{\Gamma_*}{\Gamma_{sl}}\cdot\delta(s_H - m^2_{D^{*0}}) + \left(1 - \frac{\Gamma_0}{\Gamma_{sl}} - \frac{\Gamma_*}{\Gamma_{sl}}\right)\cdot f^{**}(s_H)$$

Take $M(D^0)$, $M(D^{*0})$, Γ_{sl}, Γ_0, Γ_* from PDG 2004 :

- Γ_{sl}, Γ_0, Γ_* are obtained combining BR's for B^-, B^0 and admixture, assuming the widths are identical (not the BR's themselves), and using

$$f_-/f_0 = 1.044 \pm 0.05$$

$$\tau(B^-)/\tau(B^0) = 1.086 \pm 0.017$$

– Average:

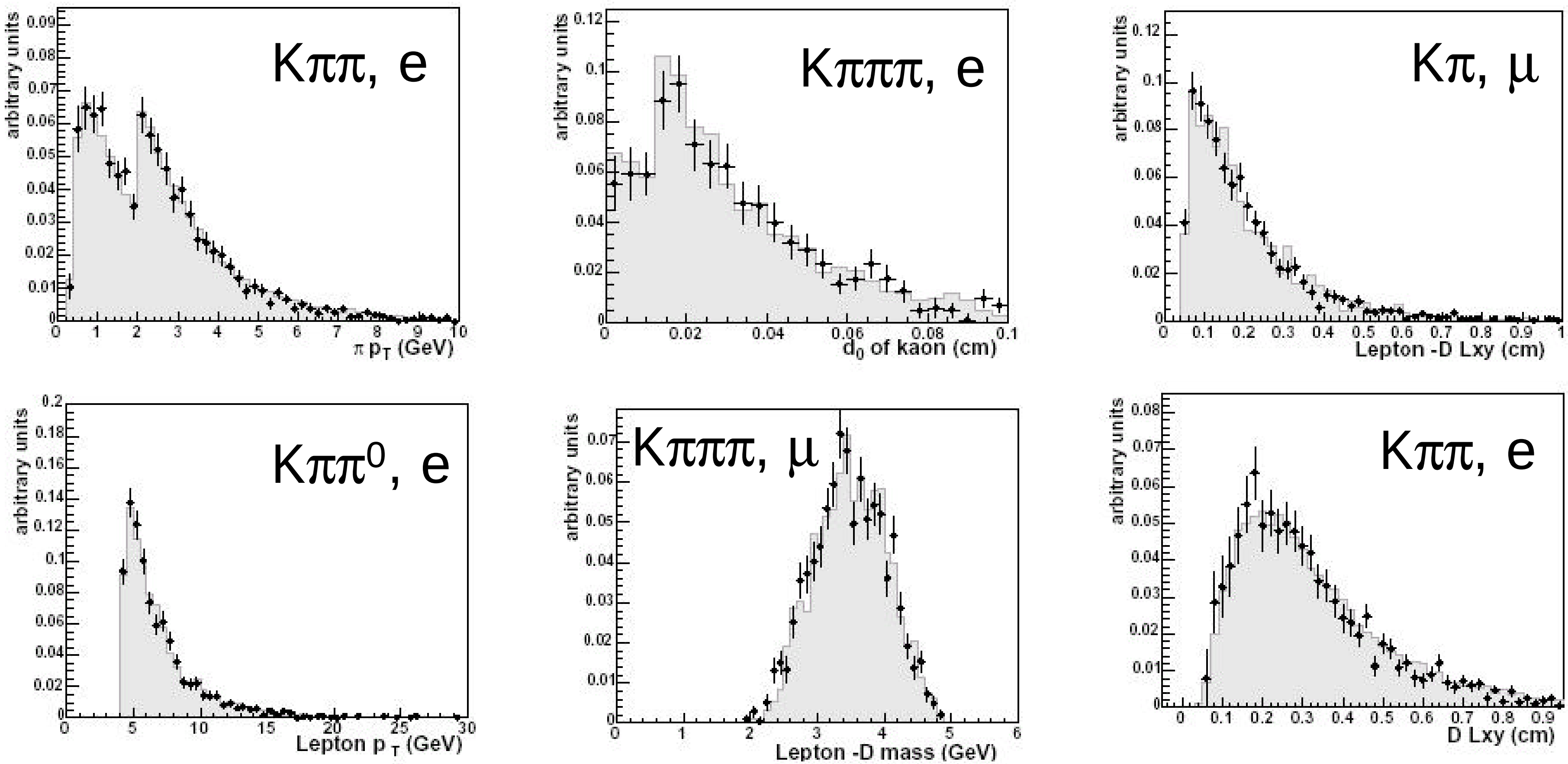
BR(B^+ ® $X^0_c l^+ \nu_l$) = 0.1099 ± 0.0031

BR(B^+ ® $D^0 l^+ \nu_l$) = 0.0223 ± 0.0015

BR(B^+ ® $D^{*0} l^+ \nu_l$) = 0.0604 ± 0.0023

Monte-Carlo Validation (I)

MC vs. semileptonic sample:



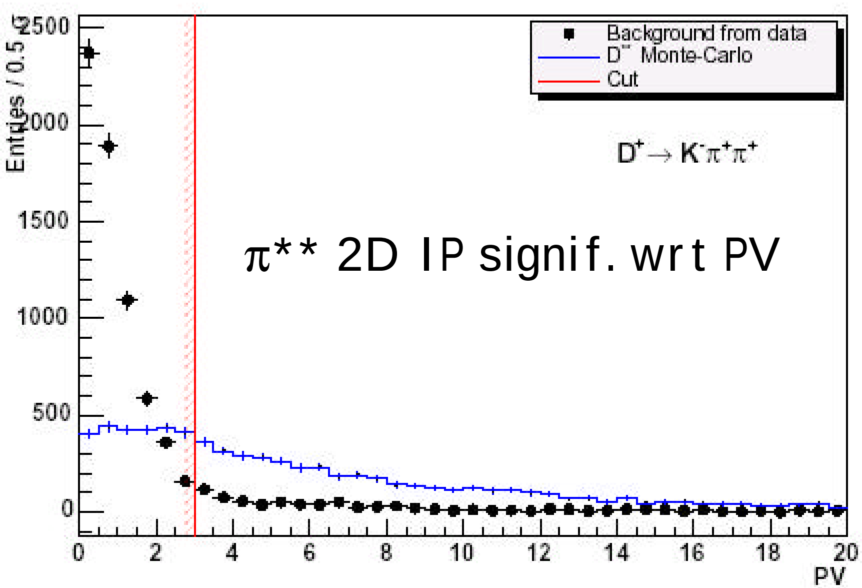
Matching c^2 probability for those plots:

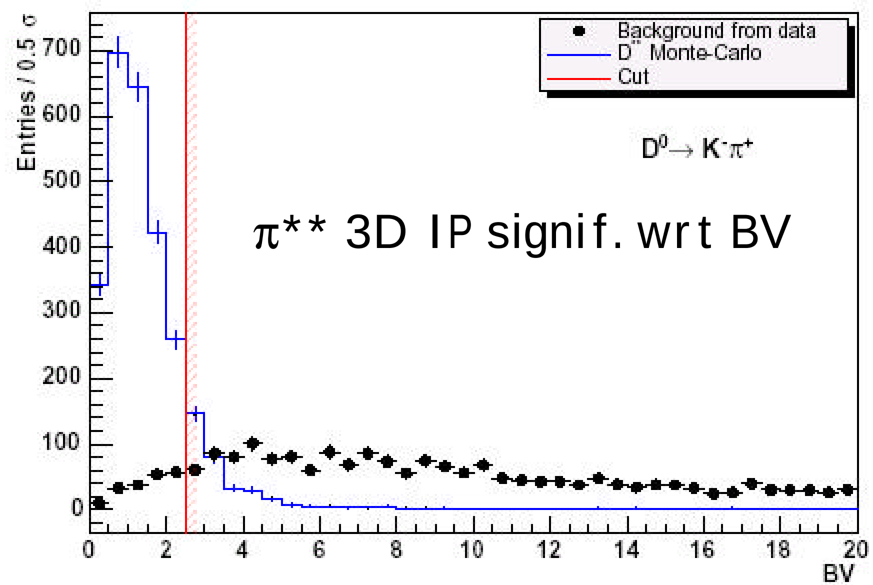
67%	74%	23%
43%	69%	87%

p** Selection

Based on topology:

- impact parameter significances w.r.t. primary, B and D vertices





Cuts are optimized using MC and background (WS) data:

Additional cuts only for D^+:

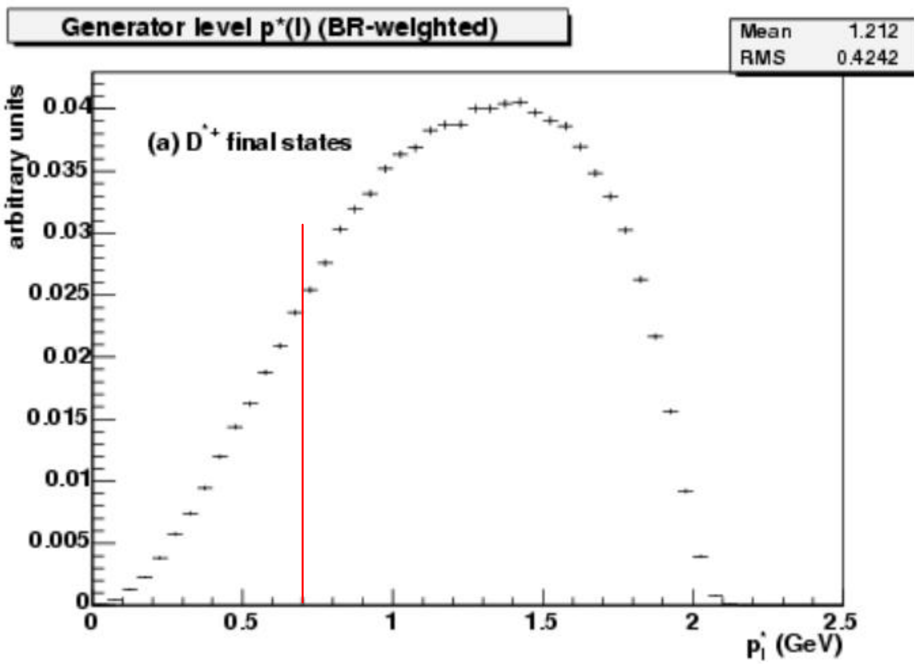
- $p_T > 0.4$ GeV
- $\Delta R < 1.0$
- $|d_0^{PV}/\sigma| > 3.0$
- $|d_0^{BV}/\sigma| < 2.5$

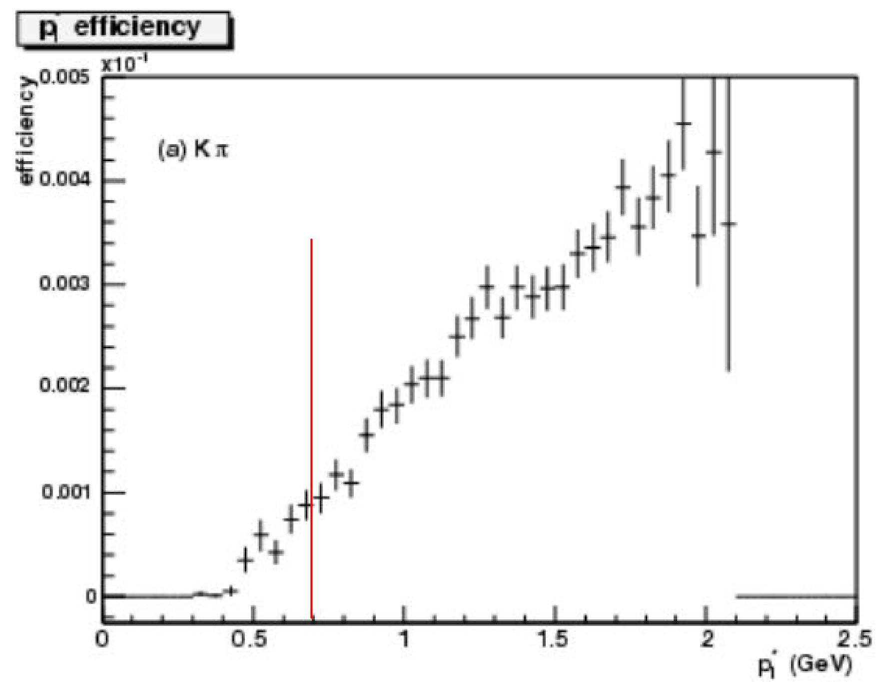
$|d_0^{DV}/\sigma| > 0.8$

$L_{xy}^{B\to D} > 500\mu m$

P_l*

- Theory prediction depends on P_l* cuts. We cannot do much but:
  - see how our efficiency as a function of P_l^* looks like
  - Use a threshold-like correction
  - Evaluate systematics for different threshold values





V_{cb} measurements

$|V_{cb}|$ from exclusive B decays

- Large statistics on $B_d^0 \to D^{(*)}\ell^- \nu$ available and new measurements are coming
- Present precision (5%) is systematics limited:

Experiments: D** states, D's BR

Theory: form factor extrapolation, corrections to $\mathcal{F}(1)=1$ can be reduced in the future

$$|V_{cb}|^{excl} = (42.1 \pm 1.1_{exp} \pm 1.9_{theo}) \times 10^{-3}$$

(PDG 2002, V_{cb} review)

$|V_{cb}|$ from inclusive B decays

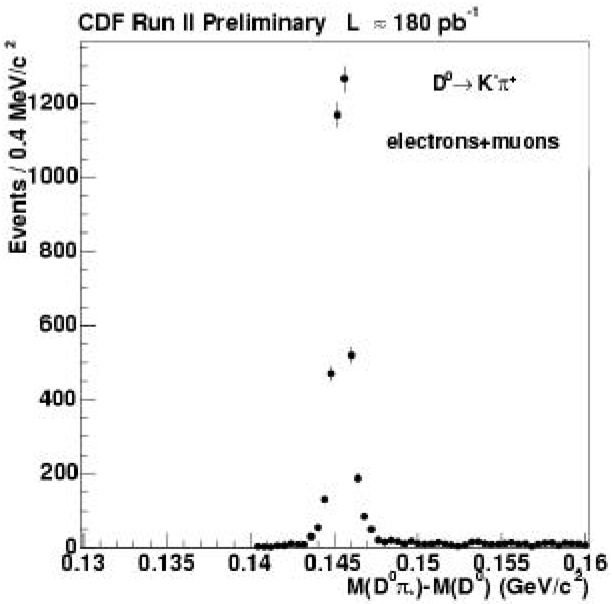
- Experiment: large statistics on $BR(B \to X_c \ell^- \nu)$ and t_B and small systematics

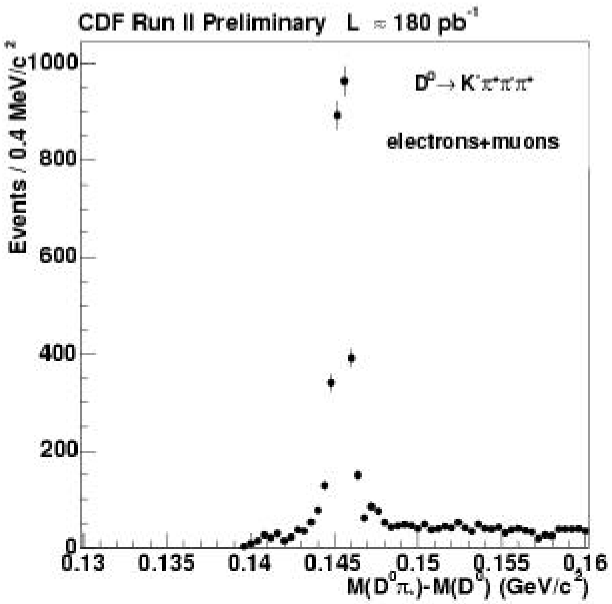
$$|V_{cb}|^{incl} = (40.4 \pm 0.5_{exp} \pm 0.5_{\Lambda,\lambda} \pm 0.8_{theo}) \times 10^{-3}$$

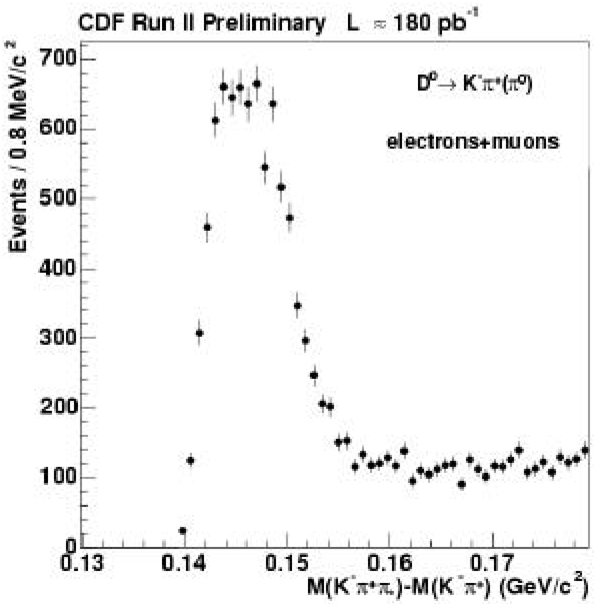
(PDG 2002, V_{cb} review)

D*+ Reconstruction and Yields

D*+ channels: $\Delta m^* \equiv M(D^0\pi_*) - M(D^0)$







$D^{(*)+}\, l^-$ (+cc) yields:

	D^{*+} channels $K^-\pi^+$	$K^-\pi^+\pi^-\pi^+$	$K^-\pi^+\pi^0$	D^+ channel $K^-\pi^+\pi^+$
$D^{(*)+}l^-$ yields				
Electrons	1723 ± 42	1299 ± 38	3037 ± 66	6859 ± 122
Muons	2168 ± 47	1695 ± 43	3611 ± 72	8204 ± 136
Combined	3890 ± 63	2994 ± 57	6638 ± 98	14416 ± 202

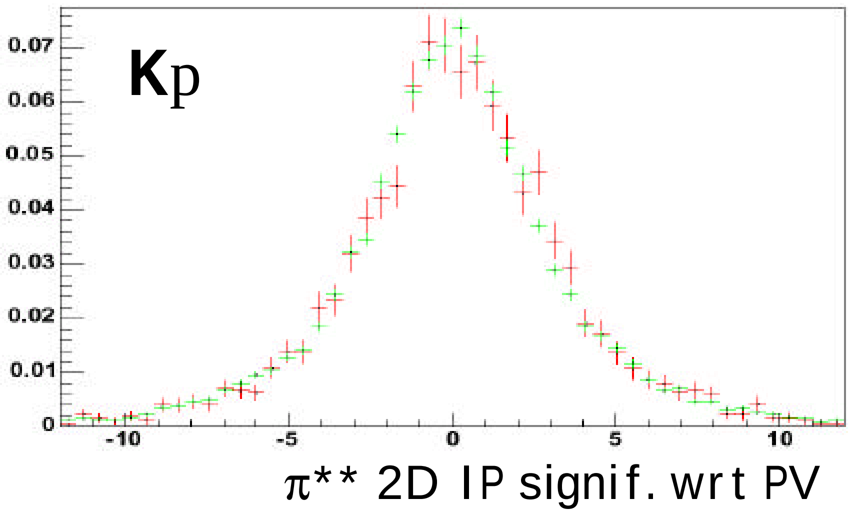
~ 28000 events

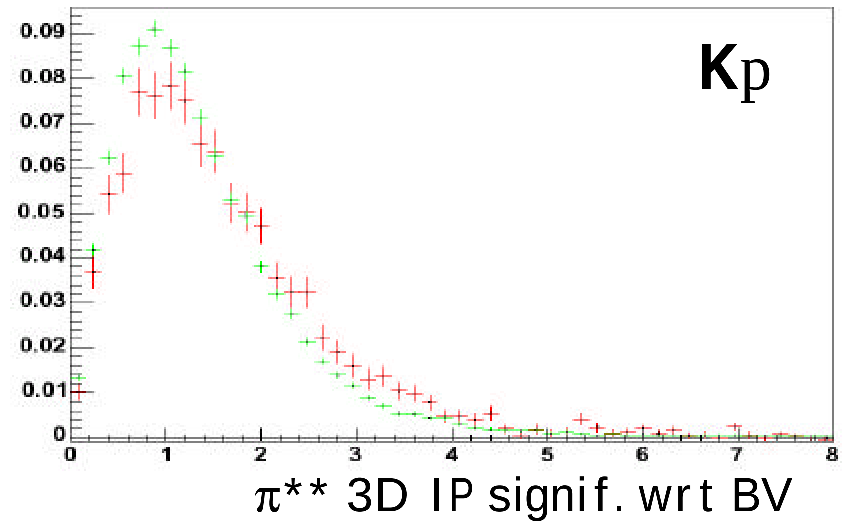
MC validation: quantitative

Matching - c^2 prob (%)	$K\pi$		$K\pi(\pi^0)$		$K\pi\pi\pi$		$K\pi\pi$	
	e	μ	e	μ	e	μ	e	μ
$p_T(l)$	4	12	43	40	38	11	16	1
$p_T(D)$	3	7	8	2	6	79	12	4
$p_T(l\text{-}D)$	41	17	30	2	49	22	9	4
$d_0(l)$	10	92	75	27	30	4	95	2
$m(l\text{-}D)$	2	3	50	61	48	69	16	42
$L_{XY}(l\text{-}D)$	48	23	41	12	32	69	29	0.07
$L_{XY}(D)$	23	88	69	99	95	47	87	2
L_{XY}(B to D)	61	29	6	13	17	89	24	2
$p_T(\pi^*)$ >0.4 GeV	28	42	21	70	38	1	–	–
$d_o(K)$	68	72	83	54	74	15	17	72
$\Delta R(l\text{-}D)$	34	29	26	51	86	33	57	30
$\Delta R(l\text{-}K)$	17	12	33	66	38	2	29	2
$p_T(K)$	22	20	49	52	83	10	25	15
$p_T(\pi)$	90	20	14	59	2	8	–	–
$p_T(2\pi)$	–	–	–	–	–	–	67	64

Impact Parameters in MC

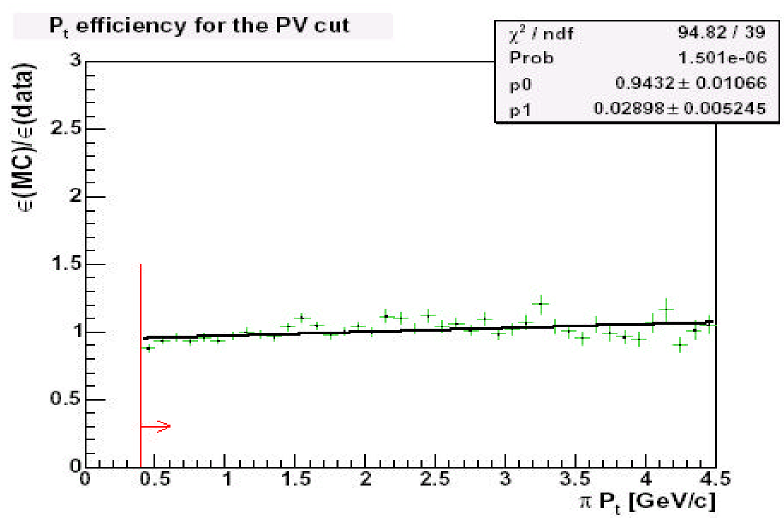
Comparison data/MC for IP: (worst case)





Residual corrections:

- derived from data:
  - p*
  - non-SVT D daughters (p_T > 1.5 GeV)
- corrections from double ratios
  - in p_T
  - in m**



Computing the X_c Moments

- The D^0 and D^{*0} pieces have to be added to the D^{**0} moments, according to

$$
\begin{aligned}
M_1 &= \mu - m_D^2 \,, \\
M_2 &= \frac{\frac{\Gamma_0}{\Gamma_{sl}} \cdot (m_{D^0}^2 - \mu)^2 f_0 + \frac{\Gamma_*}{\Gamma_{sl}} \cdot (m_{D^{*0}}^2 - \mu)^2 f_* + \left(1 - \frac{\Gamma_0}{\Gamma_{sl}} - \frac{\Gamma_*}{\Gamma_{sl}}\right) \cdot \left(m_2 + (m_1 - \mu)^2\right) f_{**}}{\frac{\Gamma_0}{\Gamma_{sl}} f_0 + \frac{\Gamma_*}{\Gamma_{sl}} f_* + \left(1 - \frac{\Gamma_0}{\Gamma_{sl}} - \frac{\Gamma_*}{\Gamma_{sl}}\right) f_{**}}
\end{aligned}
$$

f

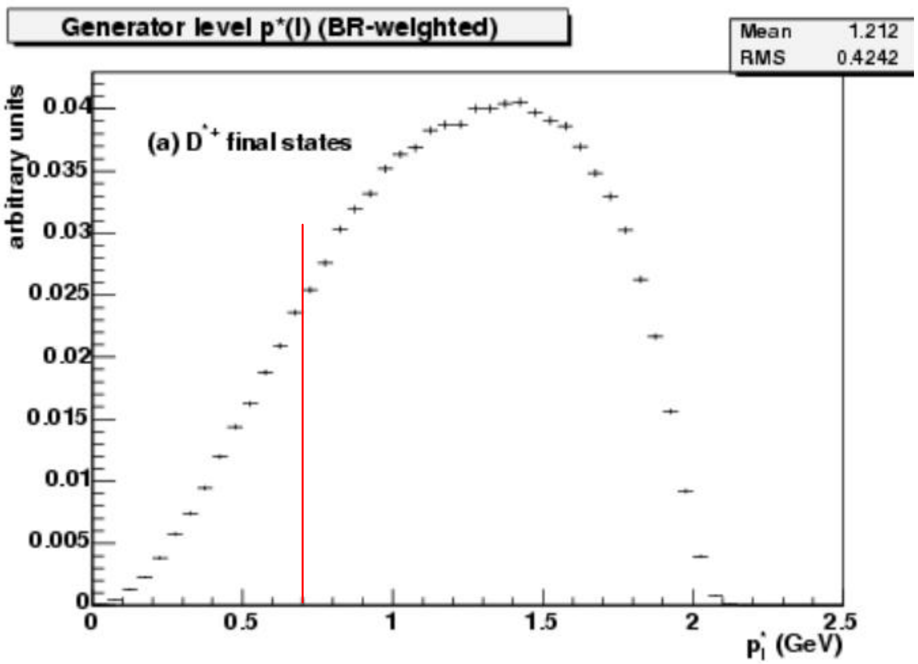
with μ defined as

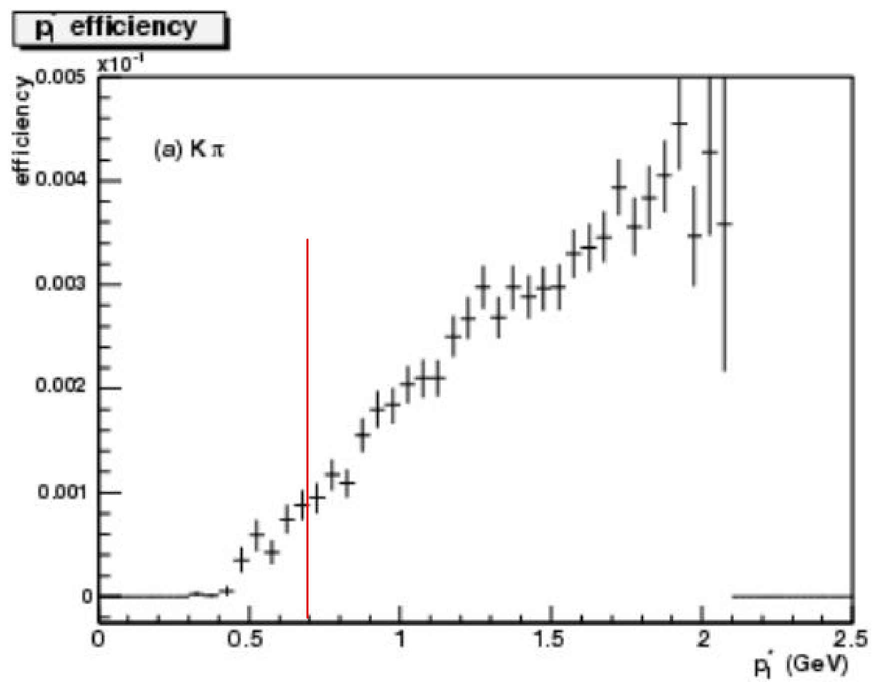
$$
\mu = \frac{\frac{\Gamma_0}{\Gamma_{sl}} \cdot m_{D^0}^2 f_0 + \frac{\Gamma_*}{\Gamma_{sl}} \cdot m_{D^{*0}}^2 f_* + \left(1 - \frac{\Gamma_0}{\Gamma_{sl}} - \frac{\Gamma_*}{\Gamma_{sl}}\right) \cdot m_1 f_{**}}{\frac{\Gamma_0}{\Gamma_{sl}} f_0 + \frac{\Gamma_*}{\Gamma_{sl}} f_* + \left(1 - \frac{\Gamma_0}{\Gamma_{sl}} - \frac{\Gamma_*}{\Gamma_{sl}}\right) f_{**}} \,.
$$

where the f_i are the fractions of $D^i l$ events above the p_l^*cut. Only ratios of f_i's enter the final result.

P_l*

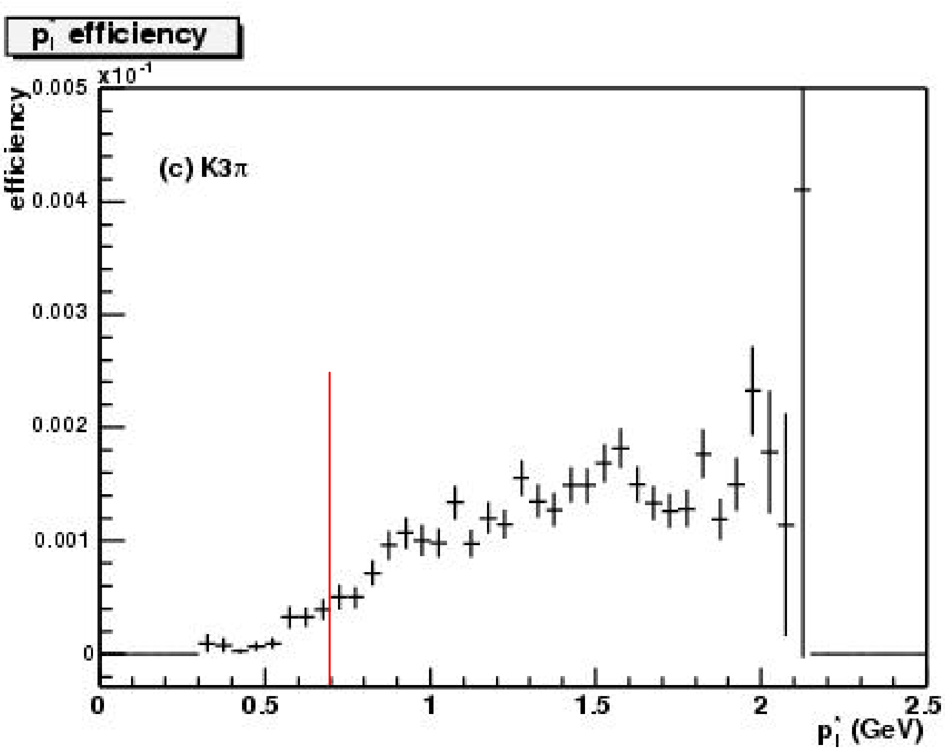
- Theory prediction depends on P_l* cuts. We cannot do much but:
  - see how our efficiency as a function of P_l^* looks like
  - Use a threshold-like correction
  - Evaluate systematics for different threshold values





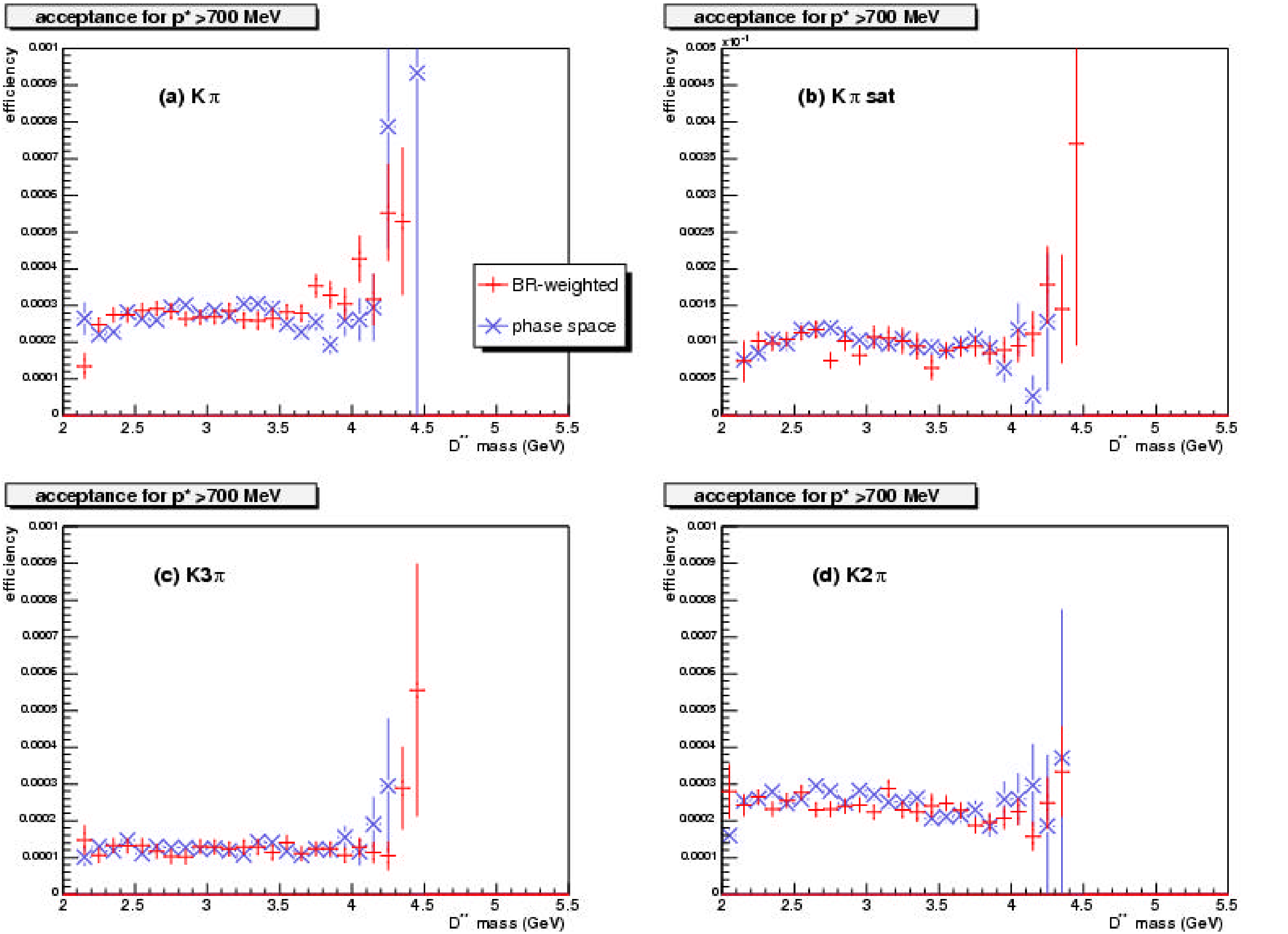
Lepton momentum cut-off

- We are not “literally” cutting on Pl* (it is not accessible, experimentally)
- Detector implicitly cuts on it
- Assume a baseline cut-off
- Vary in a reasonable range to evaluate systematics



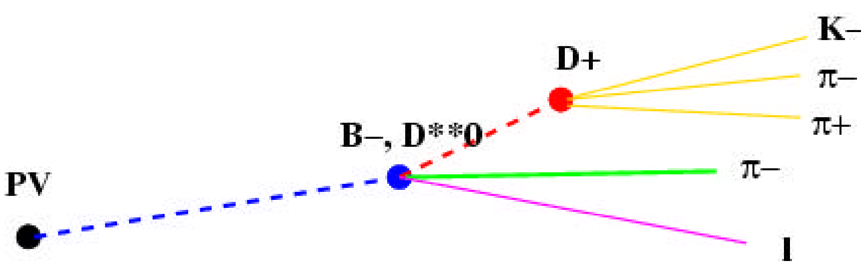
- We use f to derive f**, given f^0, f*
- $f=f(\Lambda,\lambda_1)$
- We use experimental prior knowledge on Λ,λ_1 to evaluate systematics
- Effect is negligible

Efficiency vs *m***



MC/Data corrections

- Dominant source of systematics!
- p^* reproduces p^{**} topology but statistics too low:
  - Use all D^* candidates
  - Cross check on non-triggering D^0 daughters (helps for p_T)



Background Subtraction

- Use mass side-bands to subtract combinatorial background.
- Use $D^{*+}[$® $D^0\pi^+]\ \pi^-$ to subtract feed-down from $D^{*+}[$® $D^+\pi^0]\ \pi^-$ to $D^+\pi^-$.
- Use wrong-sign $\pi^{**+}\ l^-$ combinations to subtract prompt background to π^{**}.
  - Possible charge asymmetry of prompt background studied with fully reconstructed B's: 4% contribution at most.

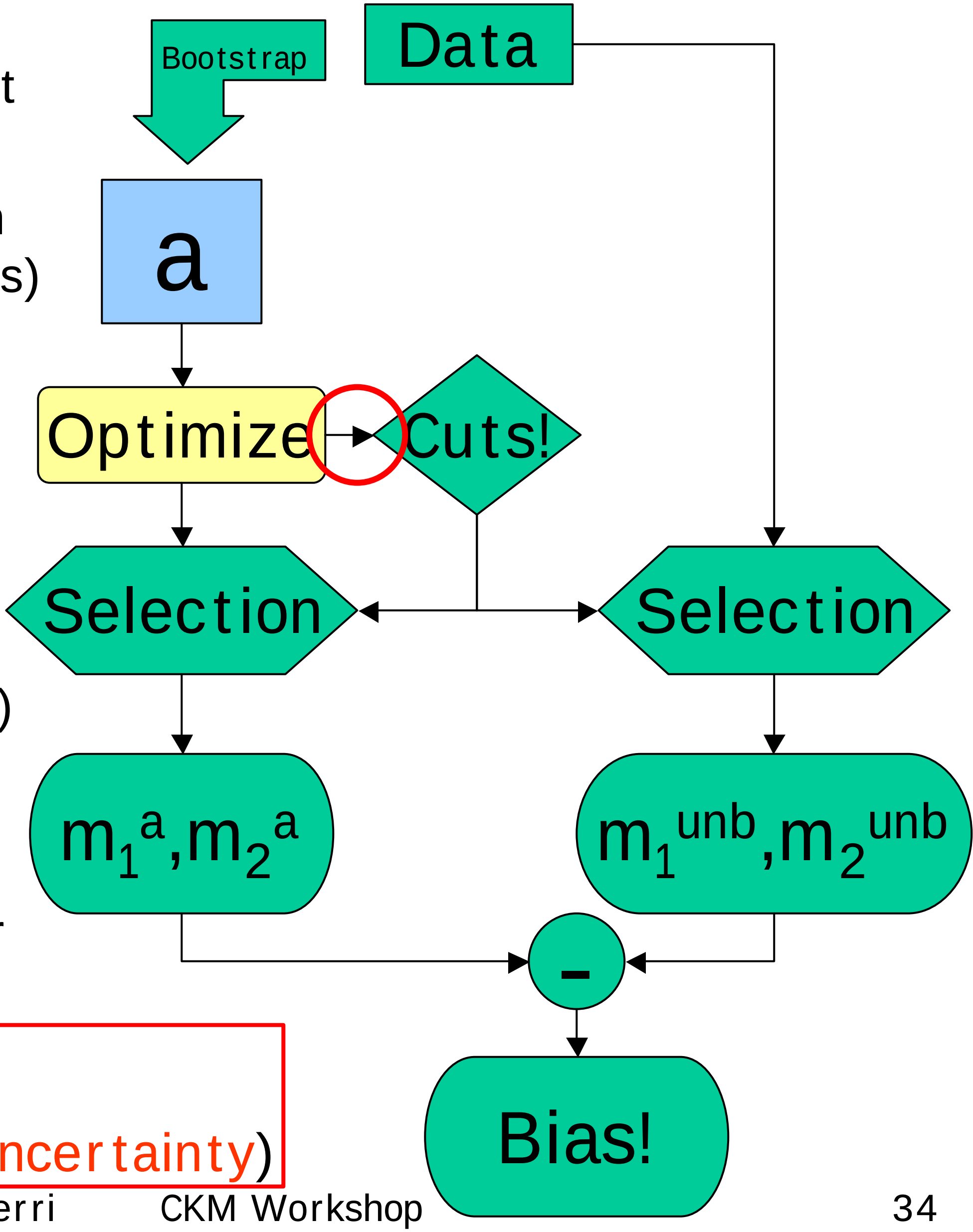
BACK-UP:
details on systematics

Systematics

- Input parameters
  - $D^{(*)+}$ Masses, in combining $D^{(*)}$ with D^{**} $m \rightarrow M$ [PDG errors]
  - BR ($B \rightarrow D^{+}/D^{*+}$ $m \rightarrow M$) [PDG errors]
- Experimental
  - Detector resolution [re-smear satellite sample by full resolution: ±60MeV]
  - Data/MC Efficiency discrepancies [measure P_t and m dependency on control sample, probe different fit models]
  - Decay models in MC [full kinematic description vs pure phase space]
  - P_l^* cut correction [repeat measurement at various P_l^* thresholds]
- Backgrounds
  - Scale [charge correlation WS/RS from fully reconstructed B: ±4%]
  - Optimization Bias [repeat optimization procedure on bootstrap copies of the sample]
  - Physics background [vary ±100%]
  - $B \rightarrow X_c \tau \nu$ [estimate τ/μ yield and kinematic differences using MC]
  - Fake leptons [no evidence in WS D^+l^+, charge-correlated negligible]

Data-based study

1. Extract a bootstrap sample a of the data
2. Optimize ⇒ get new set of cuts
3. Evaluate bias with respect to the parent distribution (initial data) with new cuts



- We can repeat this 50 times and obtain 50 independent estimates of the bias(es)
- CPU intensive

  [~5 hours/(bootstrap+optimization+"fit")]
- Mean of those estimates is an unbiased estimator of the bias

  (as long as the data is a good representation of the ideal distribution)
- σ is a convolution of:
  1) Intrinsic fluctuation of bias
  2) Statistical fluctuation of a after cuts

•μ=bias

•σ=(bias fluctuation)⊗(statistical uncertainty)

Physics Background

- Physics background studied with $B \rightarrow D^{(*)+} D_s^-$
- Size wrt signal:

$$e \times BR(D_s \rightarrow lX) \times \frac{BR(B \rightarrow D_s D^{(*)+})}{BR(B \rightarrow signal)} \times 1.5$$

~7%

~7%

~1

Other modes

- 100% uncertainty

τ Background

- A problem if observed m** distributions are different!
- Two possible sources of difference:
  - Kinematics: different m** distribution to begin with because

    $m(\tau)/m(B) \gg m(e/\mu)/m(B)$
  - Different reconstruction efficiency
- Study with generator-level MC + smearing + trigger & reco. parameterization
- Conclusion:
  - $[B\to lD^{**}\tau]/[B\to lD^{**}\mu]\approx 2\%$
  - Difference in m** acceptance is ~10% and

    mass-independent→irrelevant
  - $m(\tau)/m(B)$ matters only for the nonresonant component which is in MC 13% of the overall distribution I.e. 13%x2% ≈0.003→small

  $[(\Delta m_1,\Delta m_2)\approx(0.01\ GeV^2,0.065\ GeV^4)]$ is evaluated on the above montecarlo, the overall BKG systematics is (0.02,0.1))
  - **B® lD**t Not a Significant Source of Systematics**

Fake Correlated Leptons

•For background which is sign correlated the nastiest source is $D^{**(-)}\pi^{+}X$ where we mismatch π^{+} as a fake lepton:

	$C=D^0$	$C=D^{*0}$	$C=D_1^{*0}$
$Cl\nu$	2.2%	6.5%	0.56%
$C\pi$	0.5%	0.5%	0.15%
Cp	1.3%	1%	<0.14%
...	...	...	...

Decreasing efficiency AND BR

Assuming:

•An average efficiency equal to the one for signal

•Overall $BR(B\rightarrow D^{**(-)}\pi^{+}X)$ is at most $3xBR(B\rightarrow D^{**(-)}l^{+}X)$

•From Run I + Run II studies from Masa, $e+\mu$ fakes are about 1.6% in total for this trigger

We get a fake count of ~2.4% the signal

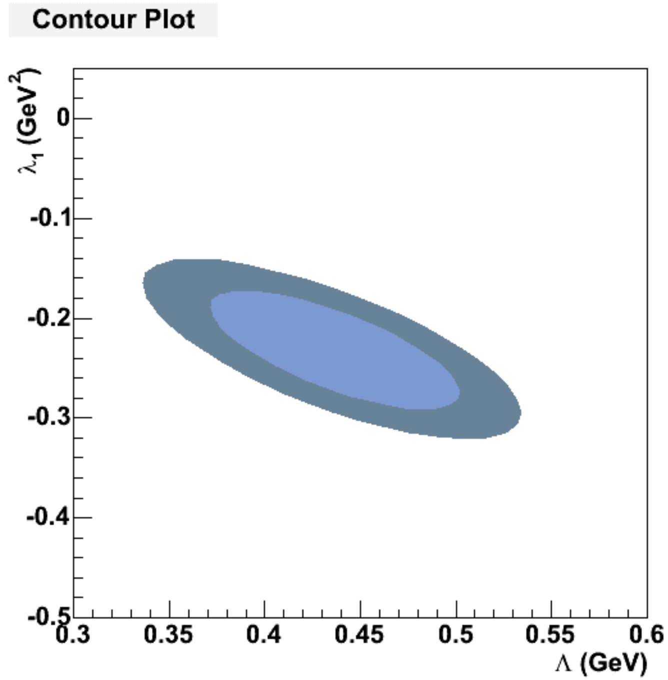
•Kinematic m** bias much smaller than for the τ background case

•Similar fake rate

Þ As negligible (or more favorable) than t

One fit to combine them all, one fit to find them!

...(Λ λ)

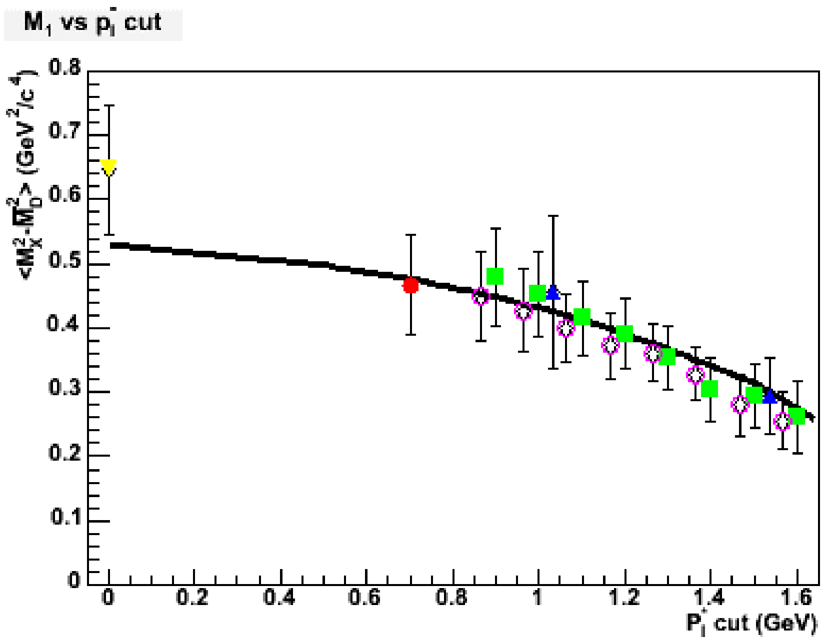


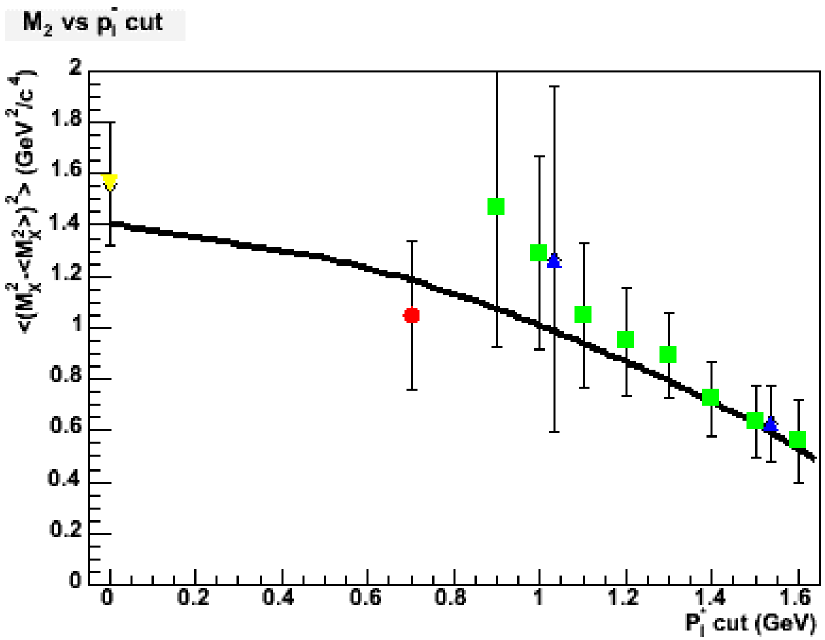
•Fit based on Bauer et al. (hep-ph/0210027)

•Fit (Λ,λ_1) in the pole scheme to moments vs p_l* cut

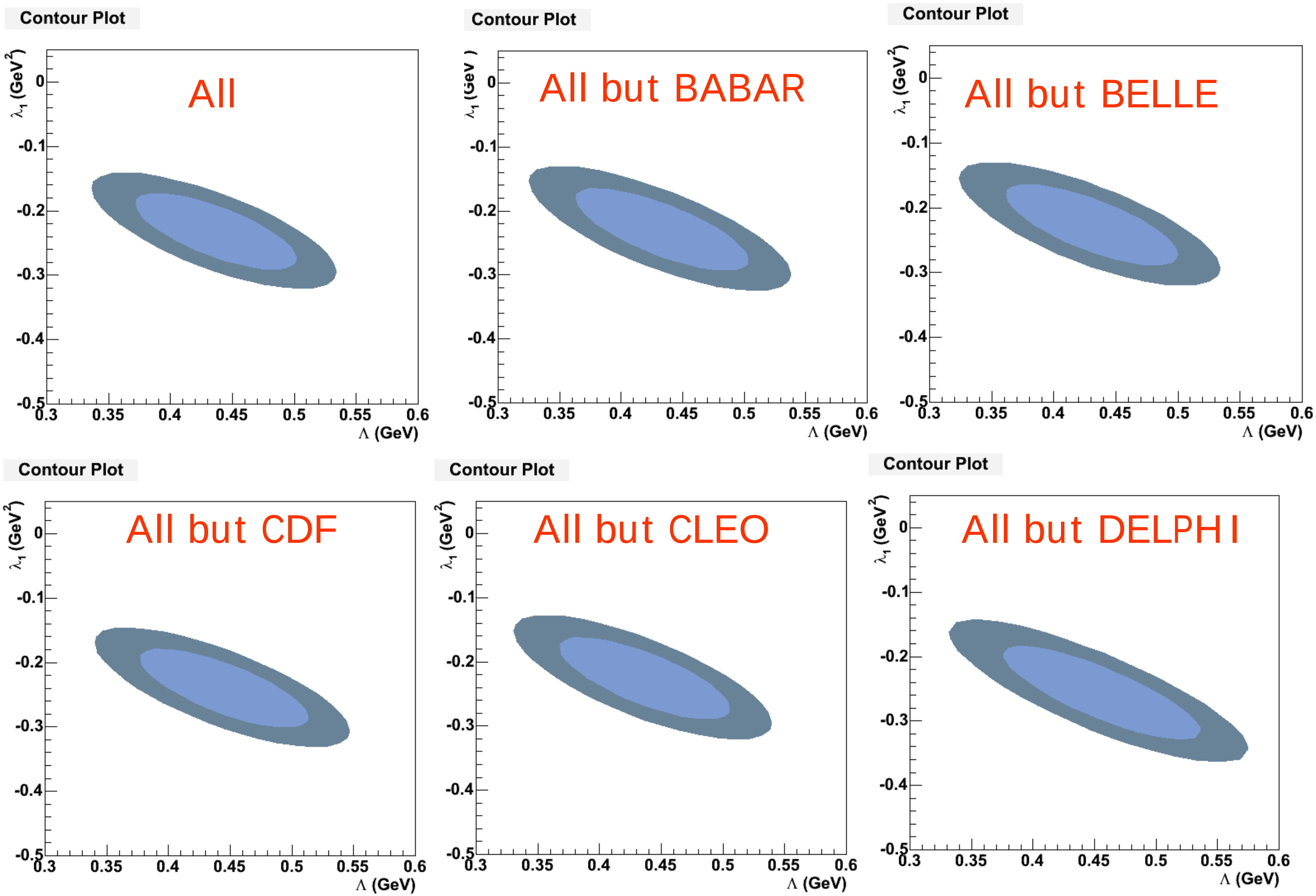
•Not including all the CLEO points

•Including BELLE's (thanks to the BELLE folks for privately providing the correlations)

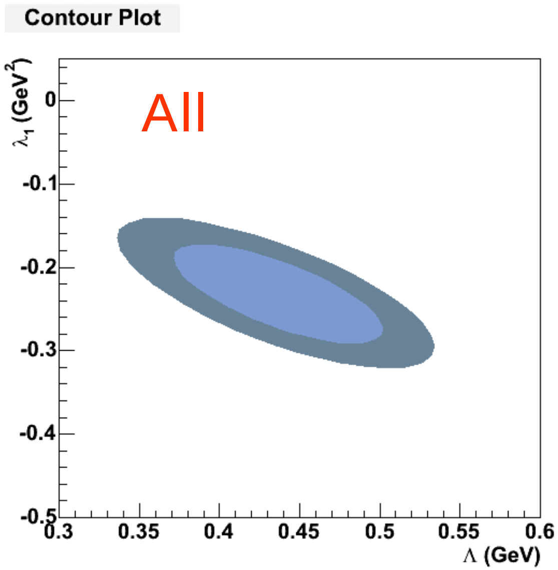


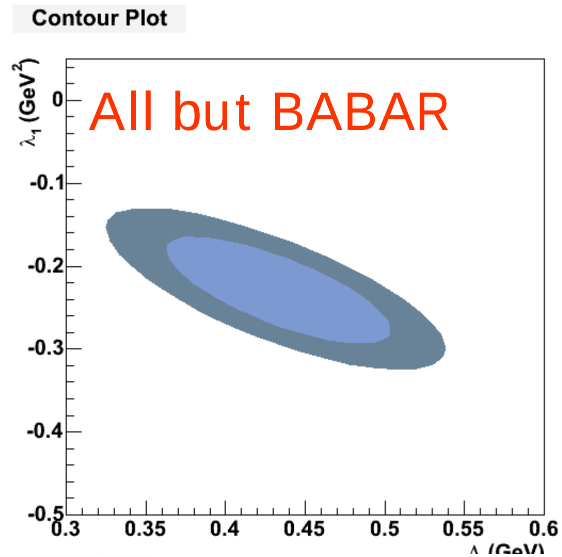


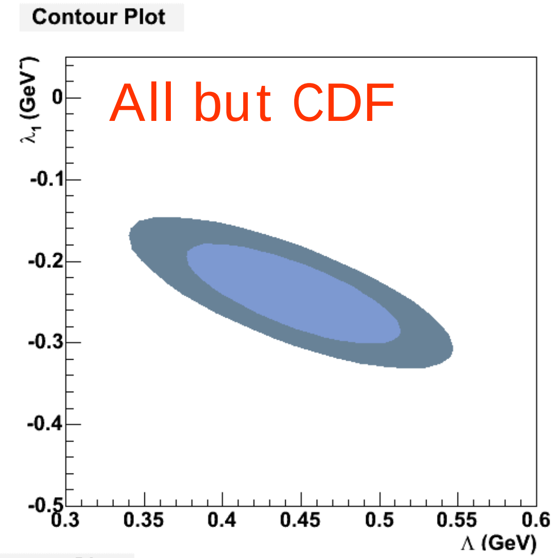
Statistical Weight



Statistical Weight







- Same fit as previous page, but excluding single experiments

- CDF contribution is significant