

Global Fit for BF and FF in $B \rightarrow D \ell \nu$ decay

Status Update

Method

- Reconstruct only D^0 and D^+ . All higher D state feeds down to D.
 - $B \rightarrow D \ell \nu$
 - $B \rightarrow D^* \ell \nu$, $D^{*-} \rightarrow D X$
 - $B \rightarrow D^{**} \ell \nu$, $D^{**} \rightarrow D X$
 - $B \rightarrow D \pi \ell \nu$ (non-resonant)
- Fit to $B \rightarrow D \ell \nu$ events.
- Bin events in 3-D : D momentum, Lepton momentum and $\cos\theta_{B-D\ell}$.
- Determine branching fractions of $B \rightarrow D \ell \nu$ and $B \rightarrow D^* \ell \nu$
- Fit is sensitive to Form Factor (FF) parameters.
 - $B \rightarrow D$ FF slope
 - $B \rightarrow D^*$ FF parameters ?

B->D Form Factor (FF)

- B->D decay is characterised by the following FF

$$\xi(w) = \xi(0) [1 - \rho^2 (w - 1)^2]$$

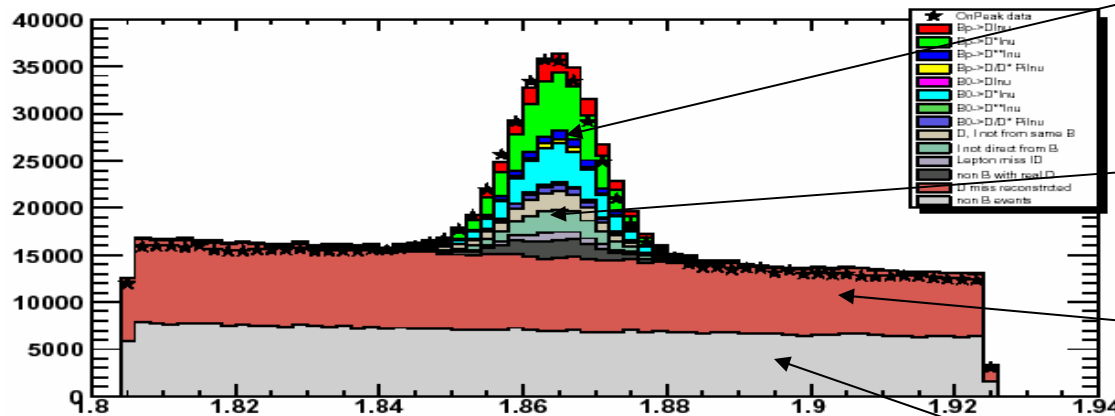
- This ρ^2 is called the “slope”
- Usually, $\xi(0) = 1$
- W is another valuable of q^2

Event Selection

- BToDlnu skim – select DI candidates
- Radiative Bhabha veto
- kaon selection : KMicroNotPion selector
- The cleanest D reconstruction modes :
D0-→KPi and D+-→KPiPi
- D and D-I vertexing by TreeFitter :
probab > 0.01 for both vertex
- Thrust cut to remove continuum (qqbar) backgrounds
 $|\cos(\text{DI-nonDI})| < 0.88$

D mass plot after all selection

D0 mass (KPi mode)

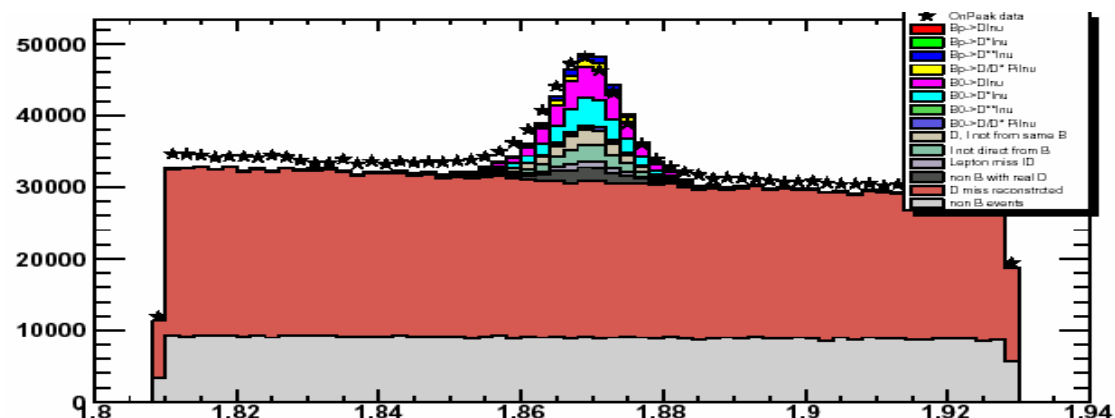


Signals

Peaking backgrounds
from B and D

Combinatorial
background
from B

D+ mass (KPiPi mode)



Continuum background
from ccbar, uds and tau

Do **sideband subtraction**
to remove non-peaking
background

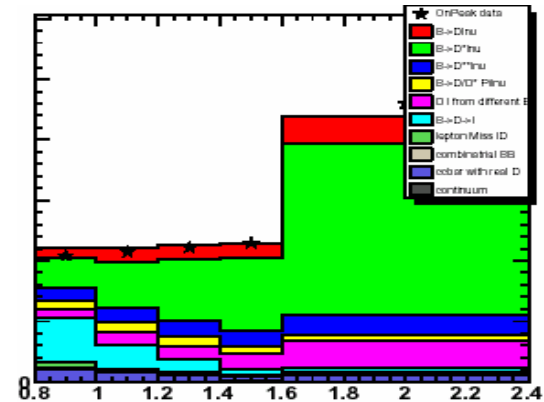
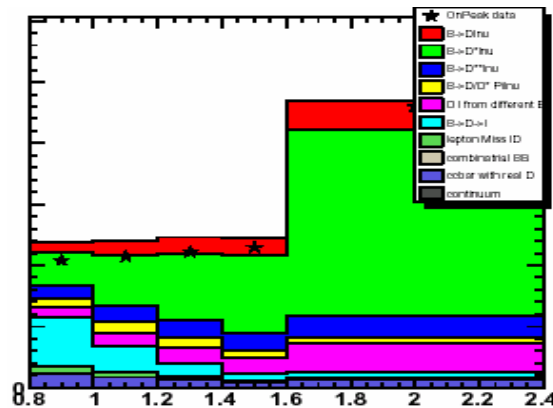
Tracking and PID correction

Lepton momentum

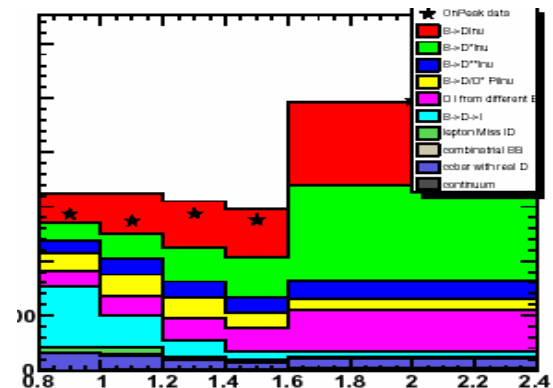
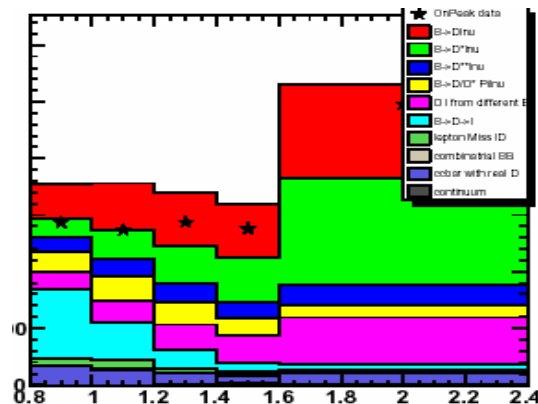
Before correction

After Correction

D0



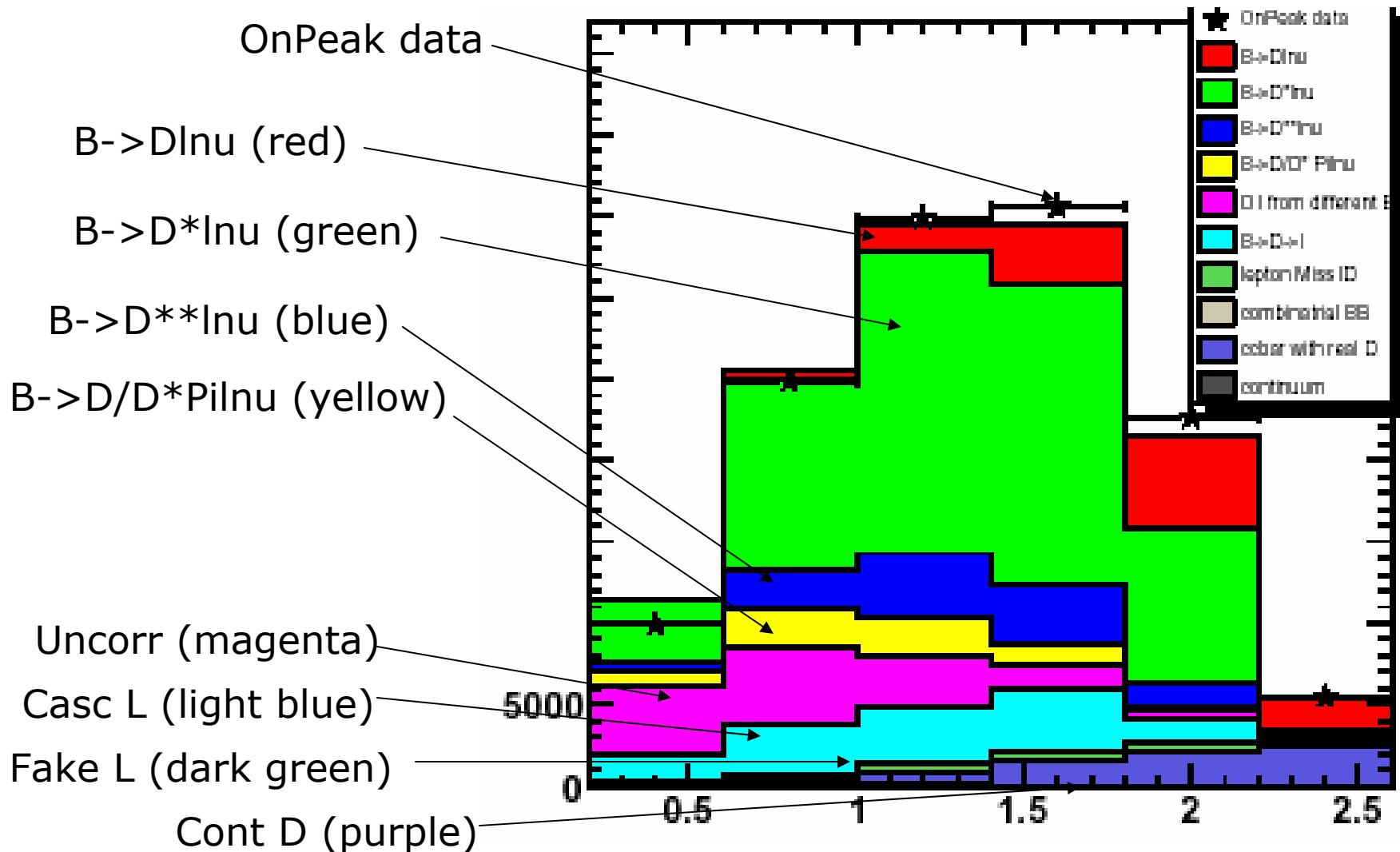
D+



New Binning

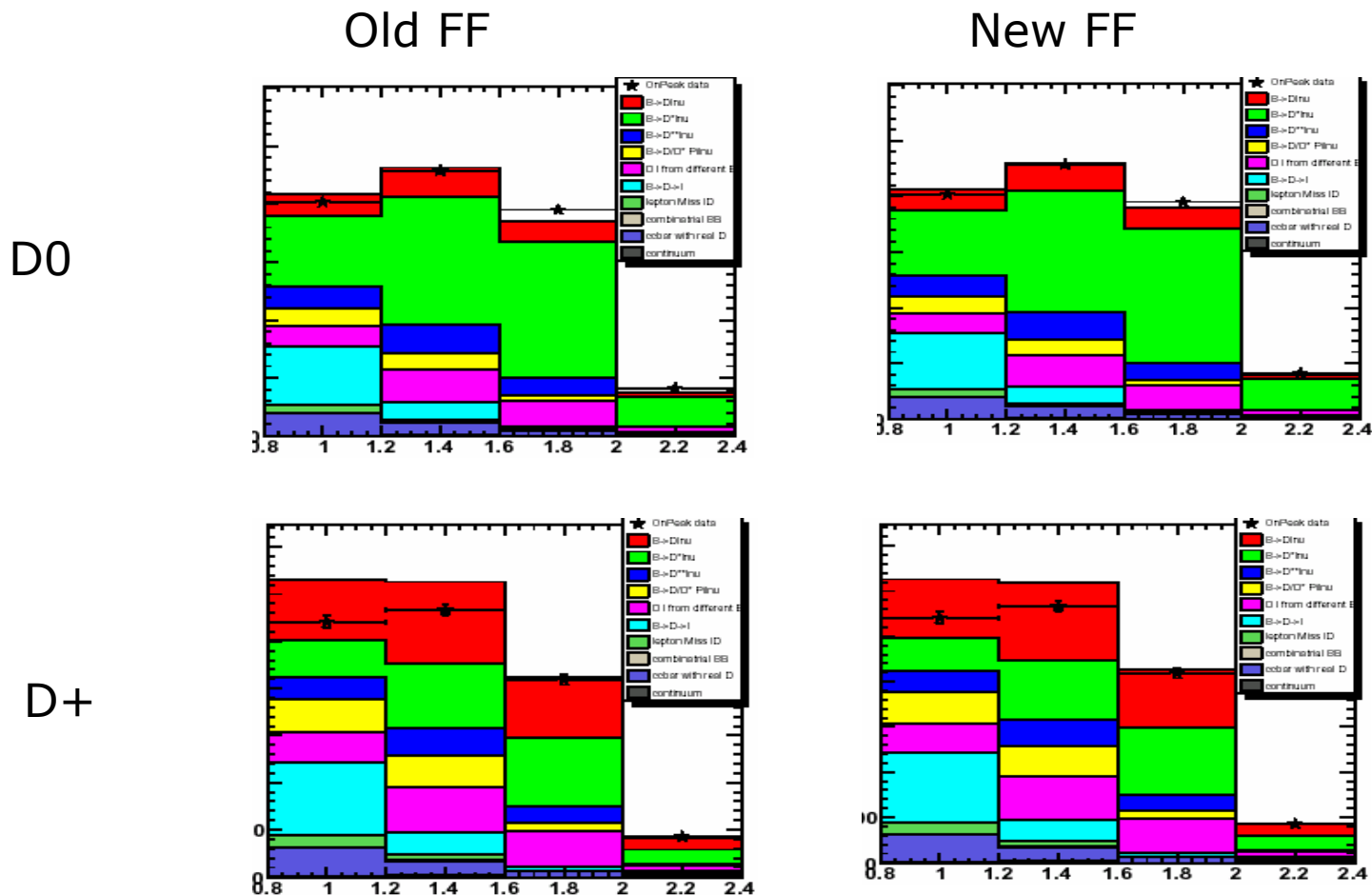
- Lepton momentum bin (4bins):
 - 0.8, 1.2, 1.6, 2.0, 2.4 GeV
- D momentum bin (6 bins):
 - 0.2, 0.6, 1.0, 1.4, 1.8, 2.2, 2.6 GeV
- cosBY bin (5 bins):
 - -10, -2.5, -1.1, 0.0, 1.1, 5
- Total $120 * 2$ (D+ and D0) = 240 bins
 - Use “#evt > 25” bins -> ~190 bins are used
- Run 3 data (30.6 fb⁻¹)
and MC (~100 fb⁻¹ of BBbar and ~50 fb⁻¹ of others)
was used.

D momentum plot (D0)



New $B \rightarrow D^*$ FF parameters

Lepton momentum



Binned chi-square fitting

$$\chi^2 = \sum_{i=\text{bin}}^{D^0} \frac{(N_i^{\text{data}} - \sum_j C_j^{MCBkgd} N_{ij}^{MCBkgd} - \sum_j C_j^{D^0} N_{ij}^{MC})^2}{(\sigma_i^{\text{data}})^2 + \sum_j (C_j^{MCBkgd} \sigma_{ij}^{MCBkgd})^2 + \sum_j (C_j^{D^0} \sigma_{ij}^{MC})^2} \\ + \sum_{i=\text{bin}}^{D^+} \frac{(N_i^{\text{data}} - \sum_j C_j^{MCBkgd} N_{ij}^{MCBkgd} - \sum_j C_j^{D^+} N_{ij}^{MC})^2}{(\sigma_i^{\text{data}})^2 + \sum_j (C_j^{MCBkgd} \sigma_{ij}^{MCBkgd})^2 + \sum_j (C_j^{D^+} \sigma_{ij}^{MC})^2}$$

- Predicted number of events ($N^{\{MC\}}$)
 - Tracking efficiency and PID corrected.
 - Luminosity normalised.
 - Form factor (FF) re-weighted.
- Coefficients (C) include
 - Branching fractions (BF)
 - Ratios like
 $f_{+0} = f_{+-}/f_{00}$, $f_{0+} = t_{00}/t_{+-}$ (life time)
 efficiency to reconstruct $D^+/D^0 = c_{D+0}$
- Isospin symmetry is assumed for $B \rightarrow D \lnu X$ decays (not for $D^{*-} \rightarrow D$).
- Use TMINUIT to minimize chi-square.

First results of fitting – FF fixed

- Constraints on $D^{**} \text{Inu}$ BF and $D \text{PiInu}$ BF
 - $\text{BF}(D0^{*} \text{Inu}) = \text{BF}(D1 \text{Inu}) * 20/56$
 - $\text{BF}(D1' \text{Inu}) = \text{BF}(D2^{*} \text{Inu}) = \text{BF}(D1 \text{Inu}) * 37/56$
 - These ratios 20/56 and 37/56 are based on SP5/SP6 value.
 - $\text{BF}(D^{*} \text{Pi Inu}) = \text{BF}(D \text{Pi Inu}) * 67/54$
 - This ratio 67/54 is based on BELLE measurement.
- Float background components
- Gaussian constraints on f_{+0} and c_{D+0}

First results of fitting – FF fixed

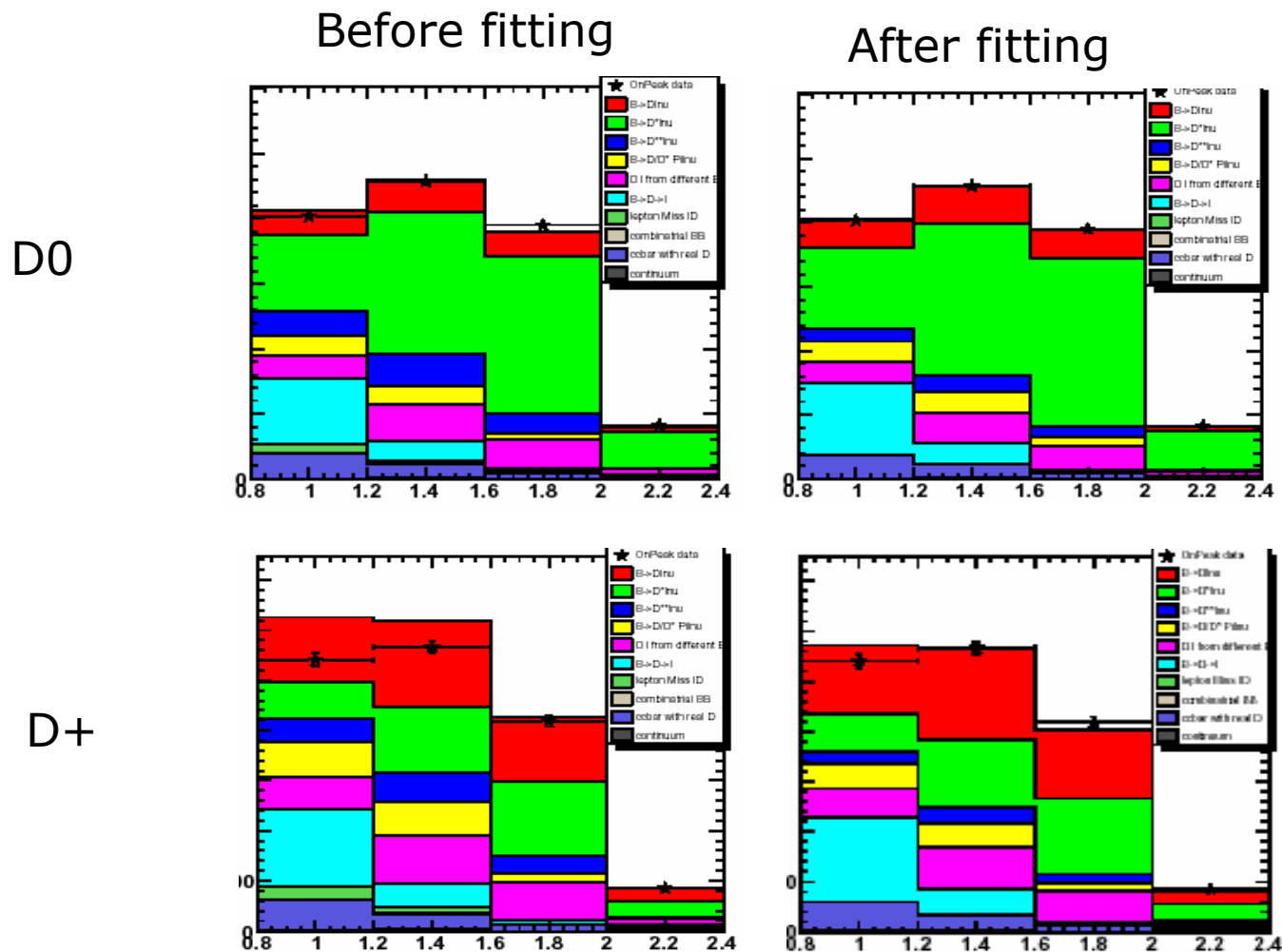
192 bins	SP5/SP6	Fitted value	New BF
Chi-square	936.735	406.595	
B->Dlnu	0.0210	0.02449 +- 1.6%	0.0236
B->D*lnu	0.0560	0.06271 +- 1.1%	0.0604
B->D0*lnu	0.0020	(0.00112)	0.0011
B->D1'lnu	0.0037	(0.00208)	0.0020
B->D1lnu	0.0056	0.00315 +- 13%	0.0030
B->D2*lnu	0.0037	(0.00208)	0.0020
B->DPilnu	0.0060	0.00367 +- 14%	0.0035
B->D*Pilnu	0.0020	(0.00455)	0.0044
Sum	0.1000	0.10385	0.100
Uncorr	1	0.877 +- 5.0%	
Casc L	1	1.119 +- 4.6%	
Cont D	1	0.968 +- 5.0%	
f_+0	1	1.0061 +- 0.8%	
c_D+0	1	0.9931 +- 0.7%	

Correlation

	D	D*	D1	D Pi	Uncr	Casc	Cont	f+0	D+0
D	1								
D*	-0.28	1							
D1	-0.08	-0.41	1						
D Pi	0.08	0.08	-0.77	1					
Uncr	-0.06	0.27	0.31	-0.36	1				
Casc	0.04	0.18	0.14	-0.47	-0.17	1			
Cont	-0.32	0.11	-0.22	0.23	0.03	-0.33	1		
f+0	0.13	-0.49	0.17	-0.01	-0.01	-0.18	0.01	1	
D+0	-0.29	0.08	0.02	0.01	-0.08	-0.04	0.02	-0.10	1

Fitted Plots (1)

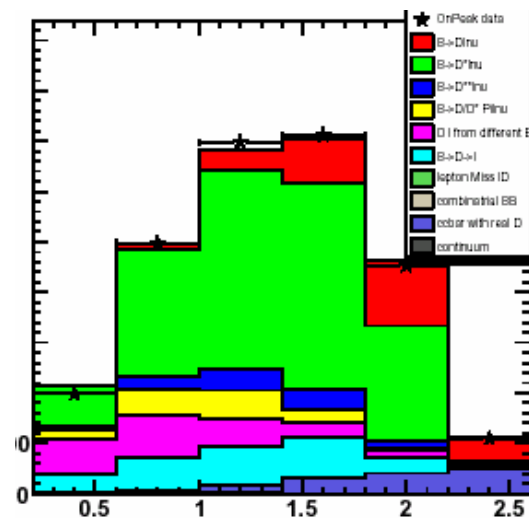
Lepton momentum



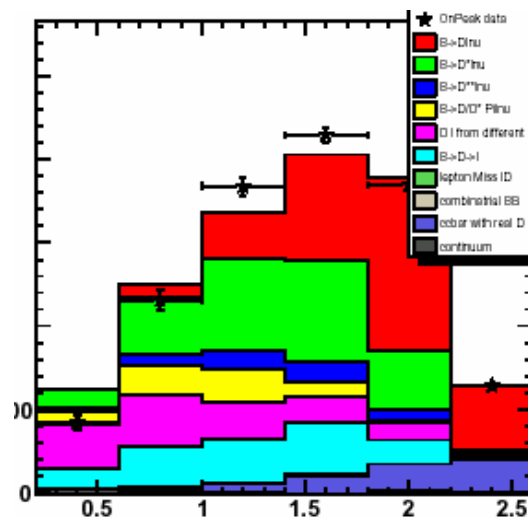
Fitted Plots (2)

D momentum

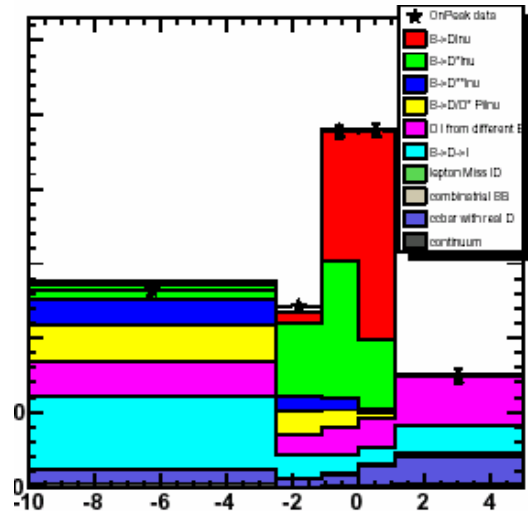
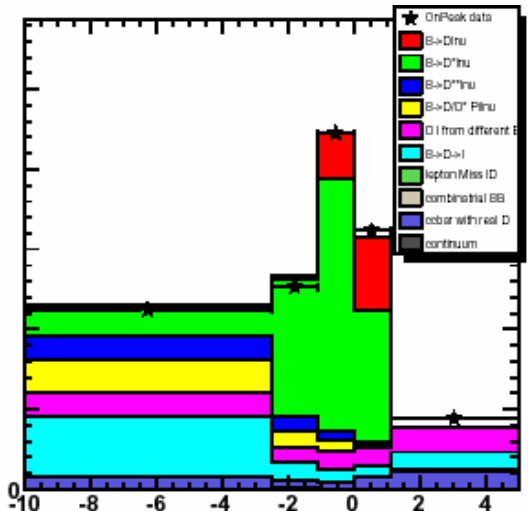
D0



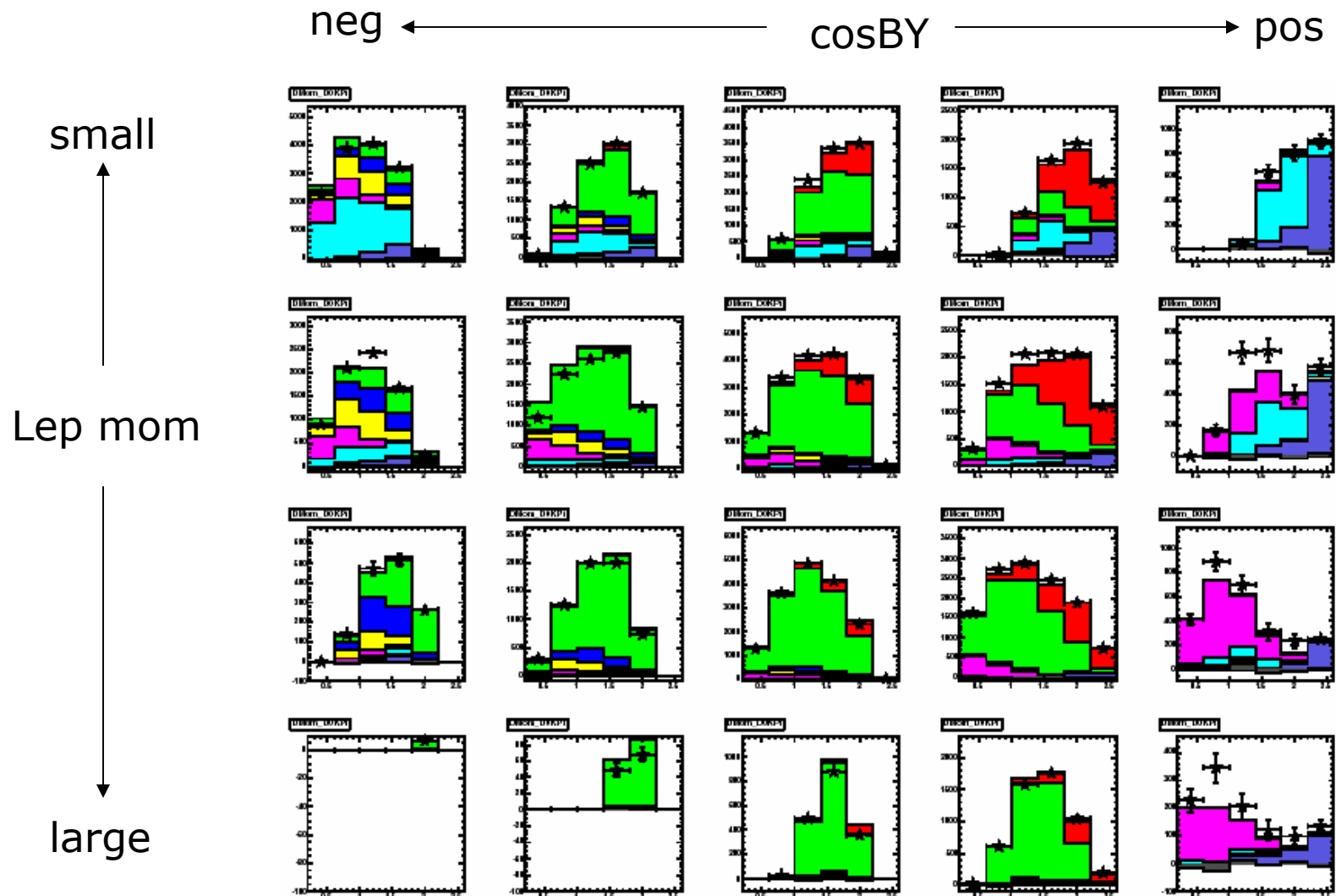
D+



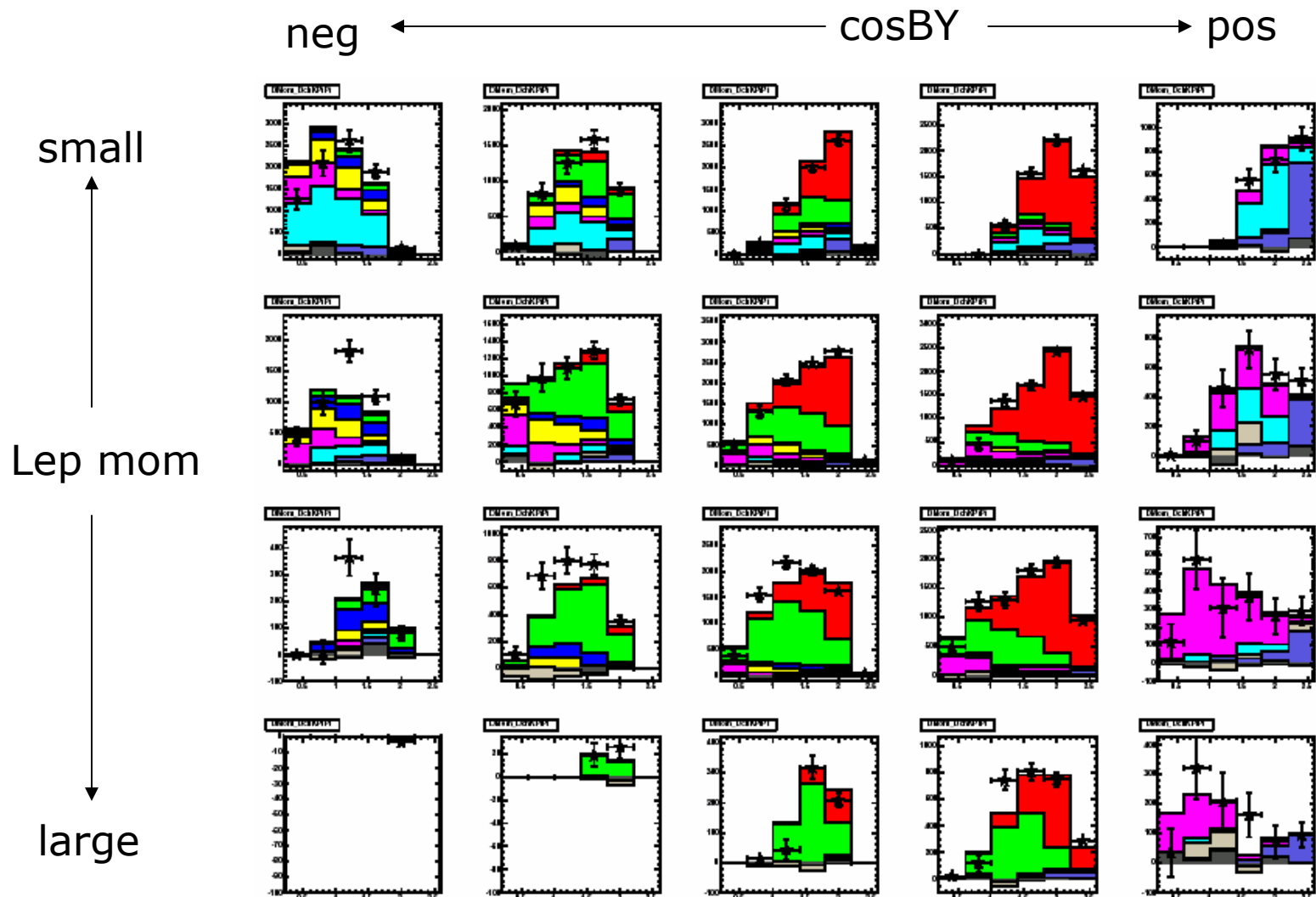
cosBY



Fitted Plots (3) – D0 momentum



Fitted Plots (4) – D+ momentum



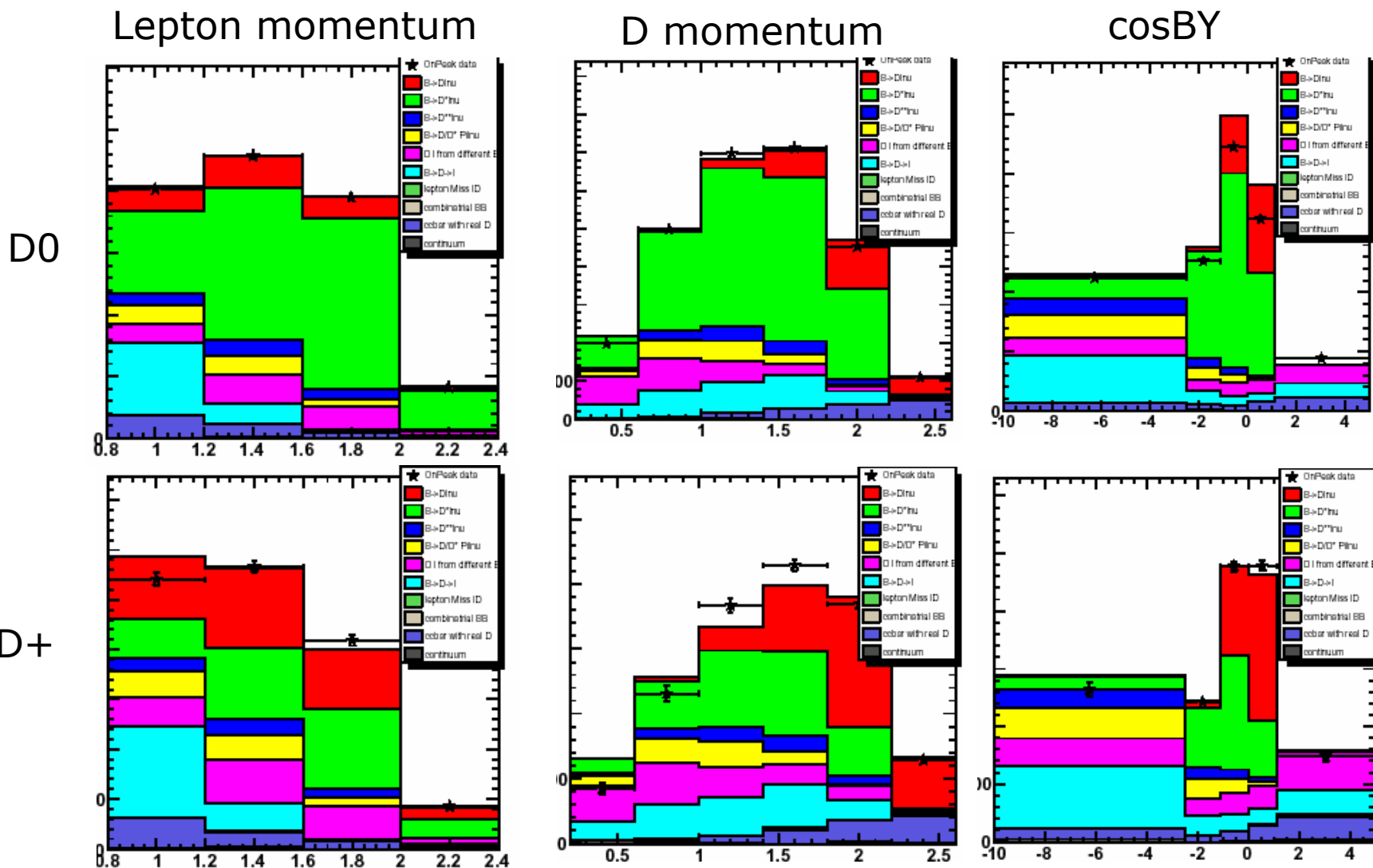
First results of B->D FF slope

160 bins	SP5/SP6	Fitted value	New BF
FF slope	0	0.725 +- 4.4 %	
B->Dlnu	0.0210	0.03797 +- 4.5%	0.0327
B->D*lnu	0.0560	0.06311 +- 1.6%	0.0543
B->D0*lnu	0.0020	(0.00099)	0.0009
B->D1'lnu	0.0037	(0.00183)	0.0016
B->D1lnu	0.0056	0.00277 +- 15%	0.0024
B->D2*lnu	0.0037	(0.00183)	0.0016
B->DPilnu	0.0060	0.00343 +- 15%	0.0029
B->D*Pilnu	0.0020	(0.00425)	0.0036
Sum	0.1000	0.11618	0.100
Uncorr	1	0.849 +- 4.4%	
Casc L	1	1.116 +- 5.3%	
Cont D	1	0.952 +- 5.6%	
f_+0	1	1.073 +- 2.4%	
c_D+0	1	1.053 +- 1.6%	

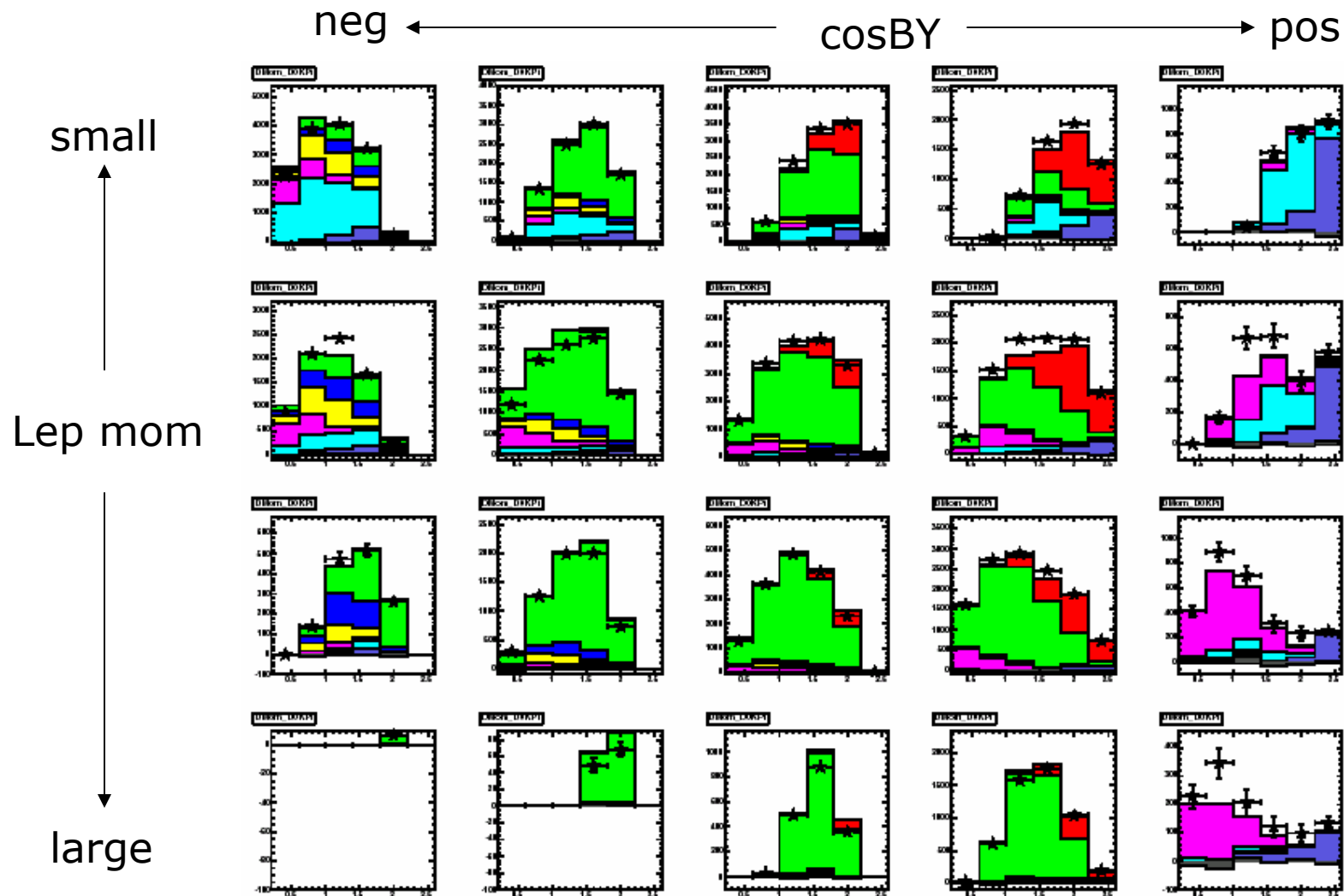
Correlation

	D	D*	D1	D Pi	Slope	Uncor	Casc	Cont	f+0
D	1								
D*	-0.15	1							
D1	0.06	-0.23	1						
D Pi	0.04	0.11	-0.75	1					
Slope	0.84	-0.29	0.05	-0.03	1				
Uncor	0.01	-0.06	0.32	-0.31	-0.05	1			
Casc	-0.10	0.36	0.11	-0.41	-0.20	-0.11	1		
Cont	0.05	0.08	-0.24	0.26	0.18	-0.01	-0.31	1	
f+0	-0.02	-0.80	-0.01	-0.08	0.26	-0.19	-0.35	-0.11	1

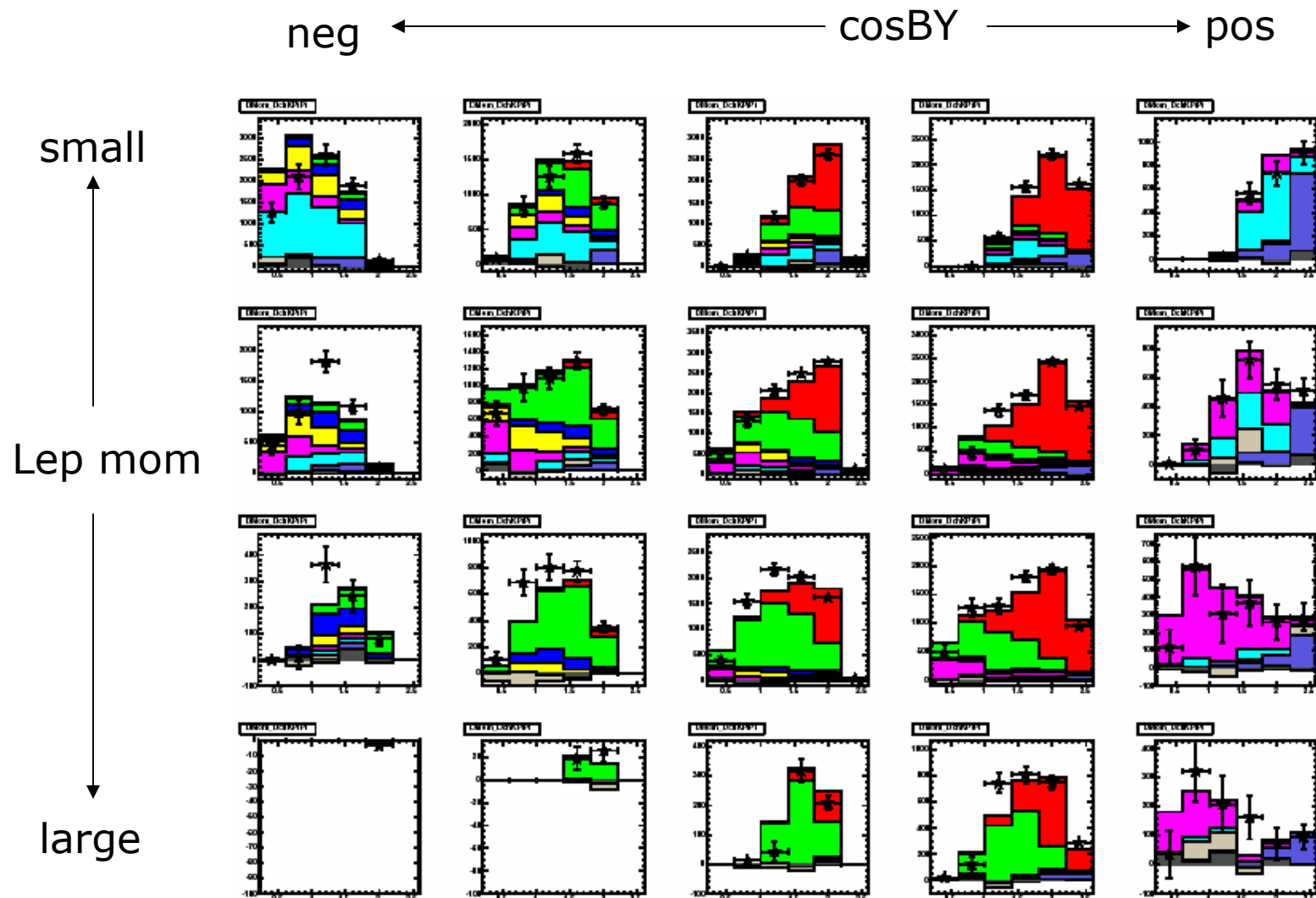
Fitted plots (1)



Fitted Plots (2) – D0 momentum



Fitted Plots (3) – D+ momentum



Next steps

- Tune/measure $B \rightarrow D^* \text{ FF}$?
- Reweight $B \rightarrow D^{**} \text{ FF}$
 - ISGW2 $\rightarrow$ LLSW (Leibovich, Ligeti, Stewart and Wise)
- Reweight $B \rightarrow D \text{ Pi} \nu$ decay
 - Tune parameters of GoityRoberts
- Tuning of fit
 - Constraints on D^{**} and $D \text{ Pi}$.
 - Which parameters to float, etc...
- Systematic study
- Write BAD