

Global Fit for Branching Fractions and Form Factor Slope of $B \rightarrow D^{(*)} \ell \bar{\nu}$ Decays

Background study and D^{**} FF re-weighting

Fitting Method

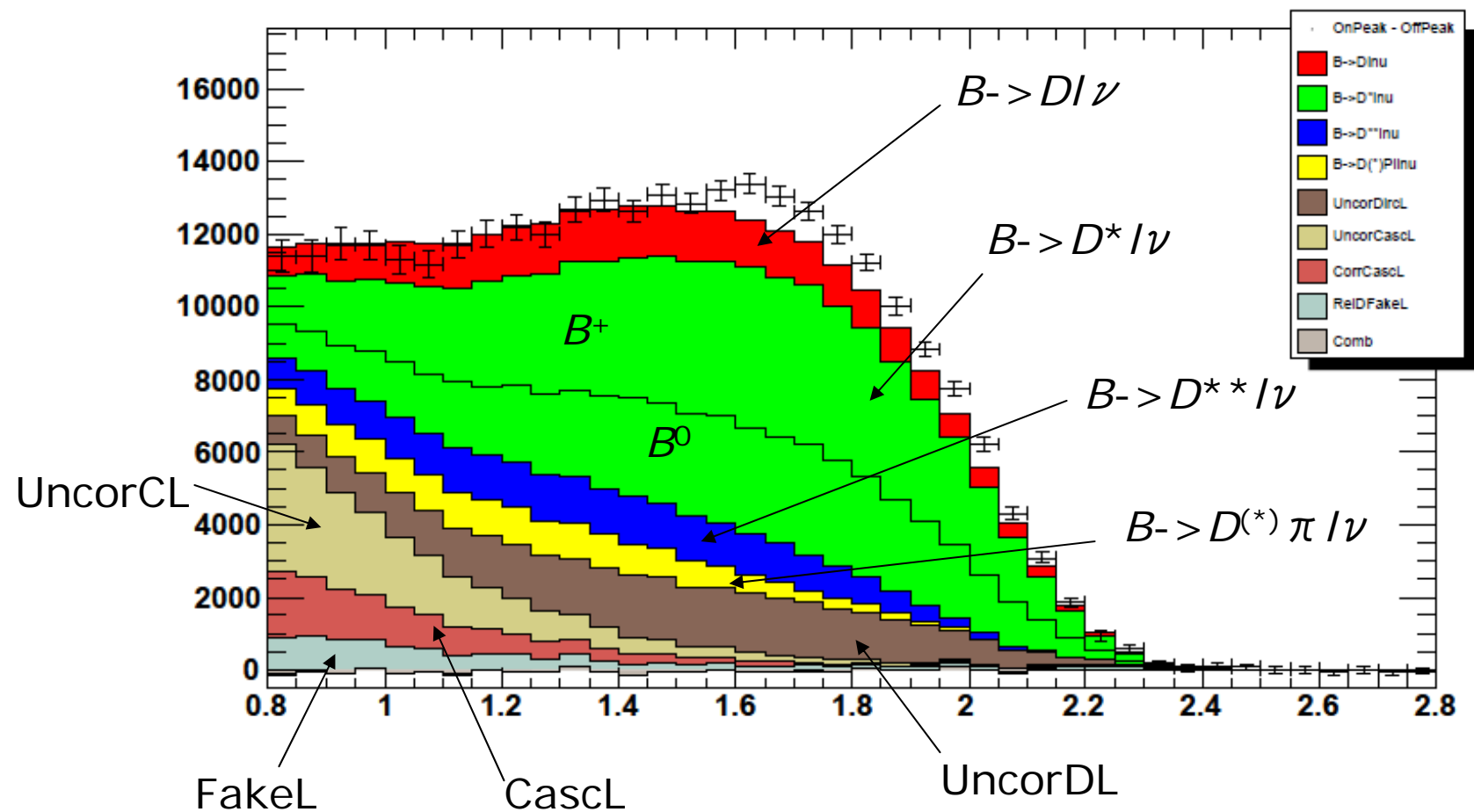
- Binned chi-square fitting

$$\chi^2 = \sum_{i=bin}^{D^0} \frac{\left(N_i^{\text{OnPeak data}} - N_i^{\text{OffPeak data}} - \sum C N_i^{B\bar{B}MC} \right)^2}{\left(\sigma_i^{\text{OnPeak data}} \right)^2 + \left(\sigma_i^{\text{OffPeak data}} \right)^2 + \sum \left(C \sigma_i^{B\bar{B}MC} \right)^2} + \sum_{i=bin}^{D^+} \frac{\left(N_i^{\text{OnPeak data}} - N_i^{\text{OffPeak data}} - \sum C N_i^{B\bar{B}MC} \right)^2}{\left(\sigma_i^{\text{OnPeak data}} \right)^2 + \left(\sigma_i^{\text{OffPeak data}} \right)^2 + \sum \left(C \sigma_i^{B\bar{B}MC} \right)^2}$$

- $N_i^{B\bar{B}MC}$: expected number of candidates from $B\bar{B}$ MC.
- C : consists of **branching fractions** to be determined by the fit.
- BF or FF **re-weighting** is done to produce $N_i^{B\bar{B}MC}$.
- 4 major backgrounds after D mass sideband subtraction.

Lepton Momentum : P_l

(OnPeak – OffPeak) data vs BB MC



Changes since last December

- Branching Fraction (BF) re-weighting for backgrounds was done.
- $B \rightarrow D^{*+} \ell \nu$ Form Factor (FF) re-weighting completed.
- Many changes and bug fixes in our fitting code.
 - Re-did event selection.
 - Changed binning.
 - D^* FF slope fitting.
 - Changed the variables to be floated in the fit.
 - Need validation.

Background Components

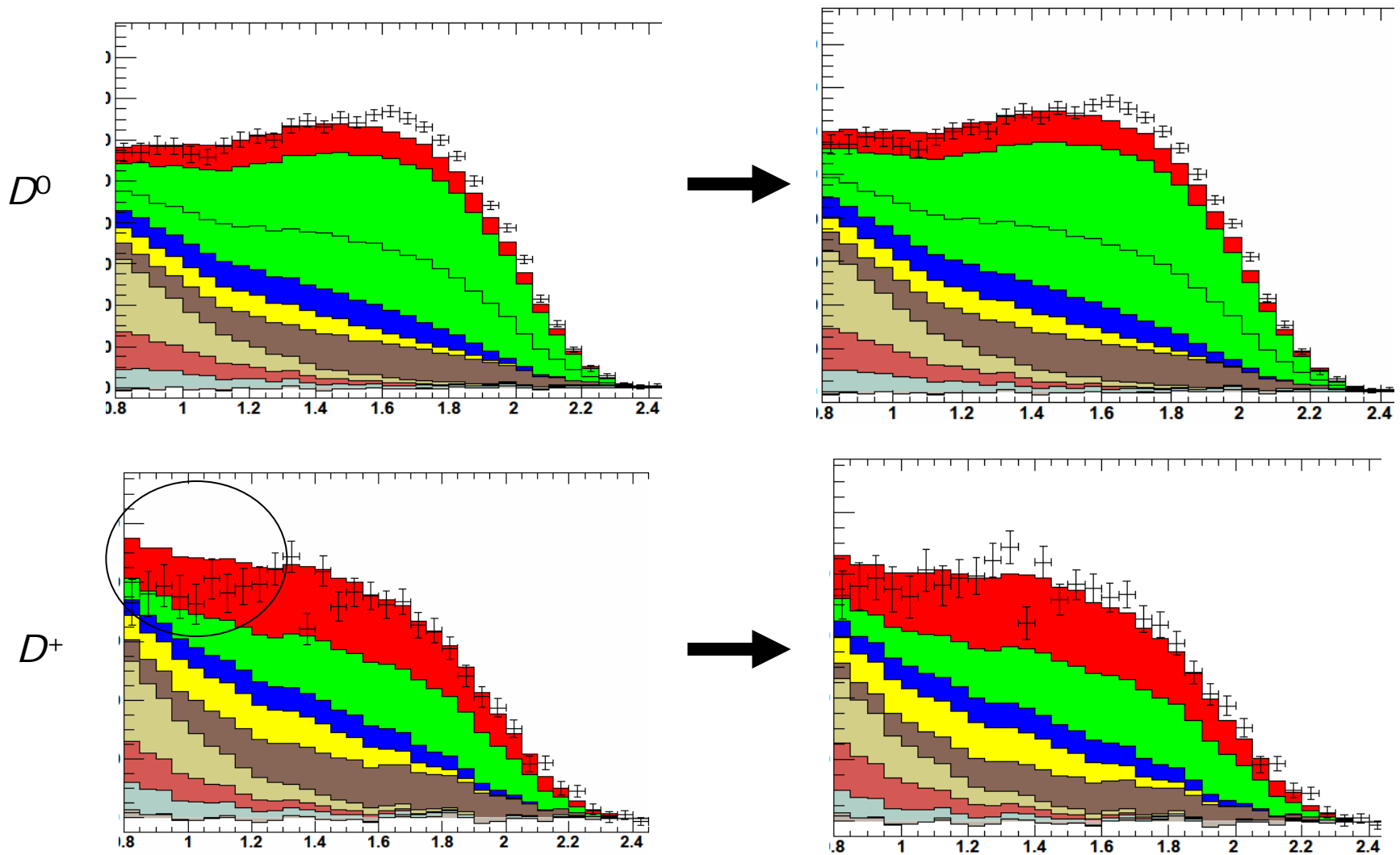
- UncorDL = Uncorrelated (= D and l from different B) and l directly from B :
 - $B \rightarrow D^{(*,**)} \overline{D}_{(s)}^{(*,**)} X$ decays : 80 % of B^+ and 40 % of B^0
 - $B^0 \overline{B}^0$ mixing : 50% of B^0
- UncorCL = Uncorrelated (= D and l from different B) and Cascade (= l not directly from B) :
 - Semileptonic D decays : 90 %
- CascL = Cascade (= l not directly from B) and correlated
 - $B \rightarrow D^{(*,**)} \overline{D}_{(s)}^{(*,**)} X$ decays + semileptonic D decays : 50 %
 - $B \rightarrow D \tau / \nu$ decays : 45 %
- FakeL = Fake lepton (= misidentified l) :
 - Misidentified π : 90 %

Background BF re-weighting

- Exclusive semileptonic D decay BF
 - For example
 - $D^+ \rightarrow K^* l \nu$: weight = 1.1625
 - $D^+ \rightarrow K l \nu$: weight = 1.3209
 - $D^0 \rightarrow \pi l \nu$: weight = 0.7297
- Inclusive $B \rightarrow D$ BF for cascade backgrounds
 - For example

Mode	Weight
$B^- \rightarrow D^+$	0.7344
$B^+ \rightarrow D^+$	0.5835
$B^0 \rightarrow D^+$	0.8043
$\underline{B}^0 \rightarrow D^+$	0.5792

P_f : BF re-weighting



Form Factor Re-weighting

- $B \rightarrow D/\nu$: ISGW2 \rightarrow HQET

$$h_+(w) = h_+(1)[1 - \rho_D^2(w-1)]$$

Slope

- $B \rightarrow D^*/\nu$: HQET

- Babar measurement of R_1 , R_2 and **slope** ρ^2 .

- $B \rightarrow D^{**}/\nu$: ISGW2 \rightarrow HQET

- Based on LLSW paper (Leibovich, Ligeti, Stewart and Wise, PRD57(1998)308, hep-ph/9705467)

- Normalization

- Total decay rate should stay same

$$\Gamma = \int \frac{d\Gamma(\text{old FF})}{dw} dw = R_N \int \frac{d\Gamma(\text{new FF})}{dw} dw$$

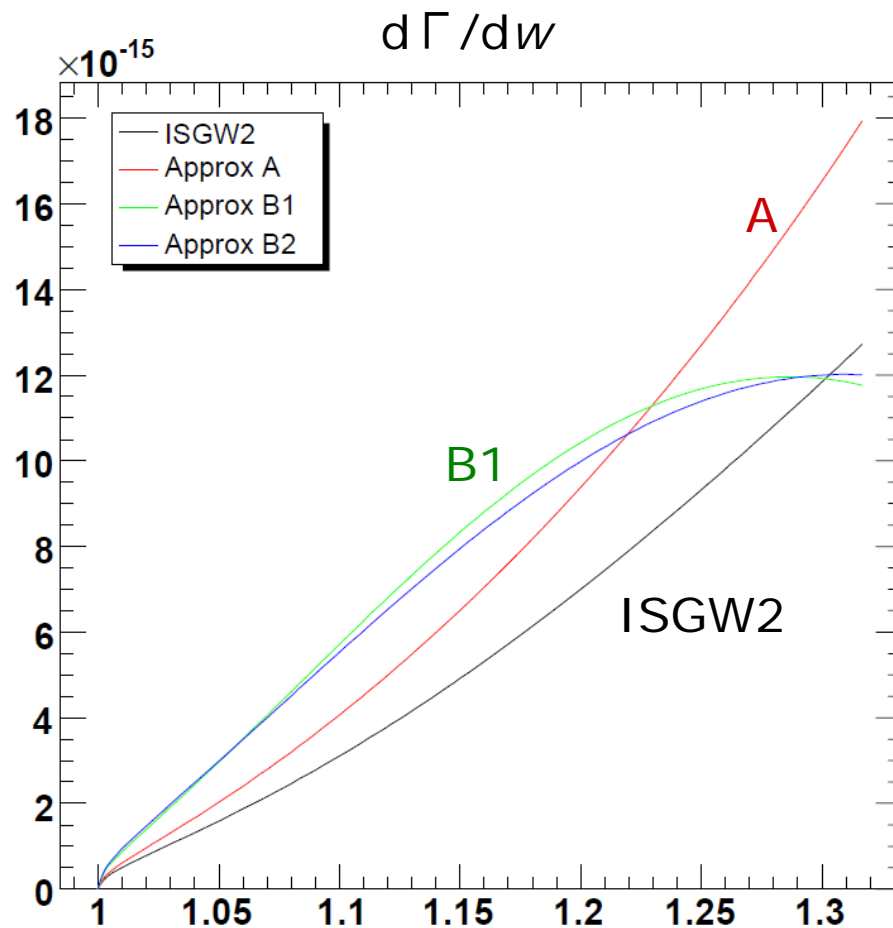
- R_N is the normalization factor

$B \rightarrow D^* \ell \nu$ FF : LLSW model

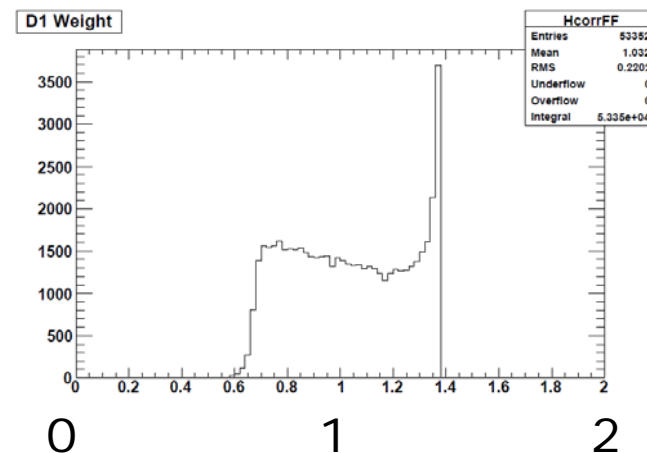
- Heavy Quark Effective Theory (HQET) is employed.
- Two approximations were employed:
 - Approximation A :
 - Expand the differential decay rates by $(w-1)$.
 - Useful only near $w = 1$.
 - Approximation B :
 - Keep the known order of $(\Lambda_{\text{QCD}}/m_Q)$ to FF
 - Keep full w dependence
- We use the Approximation B
 - Form factors are proportional to $\tau(w)$
 - $\tau(w) = \tau(1) [1 + \tau'(w-1)]$
 - $\tau(1) = 0.71$, $\tau' = -1.5$ are used.

Slope

D_1 $d\Gamma/dw$ and Weights

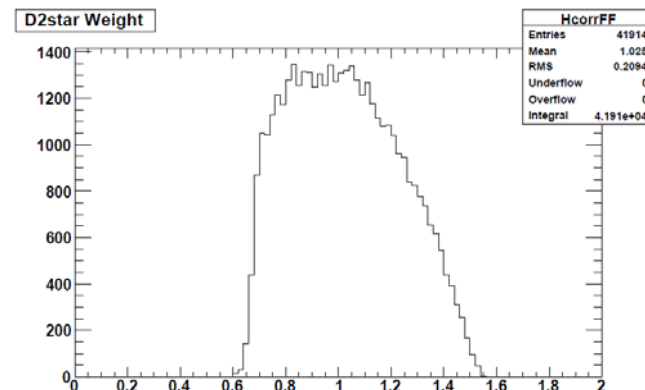
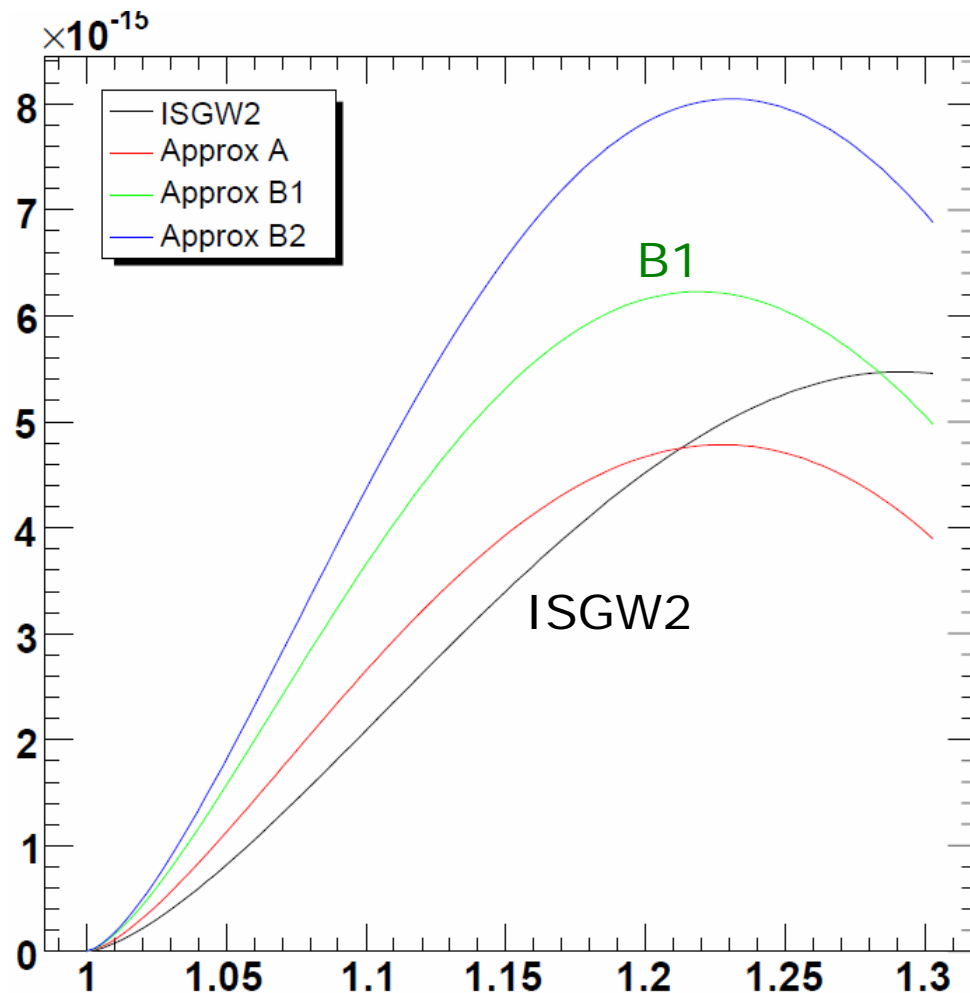


weights



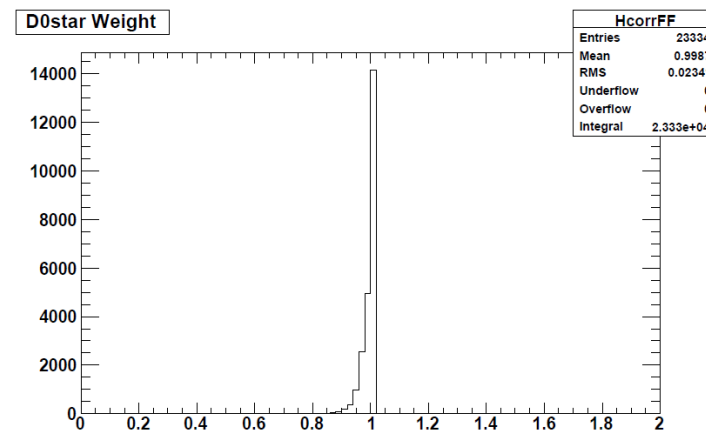
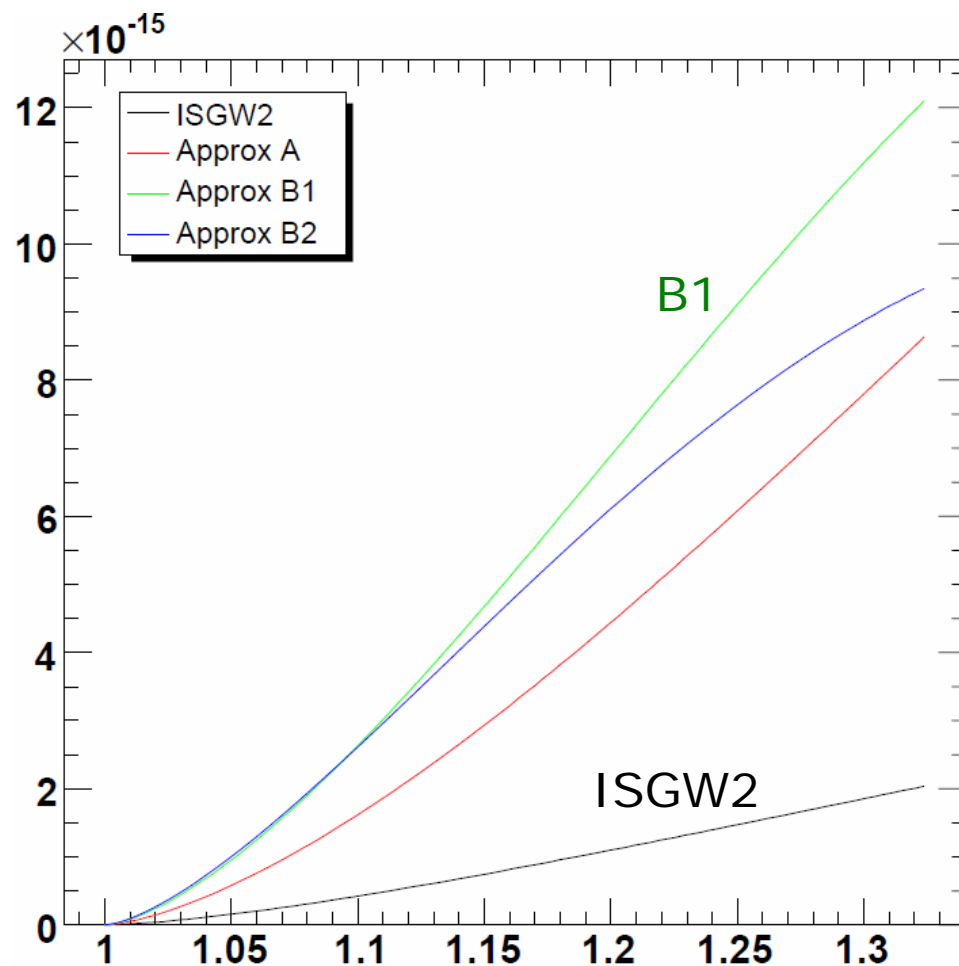
$$R_N = 0.733$$

$D_2^* \text{ d}\Gamma/\text{d}w$ and Weights



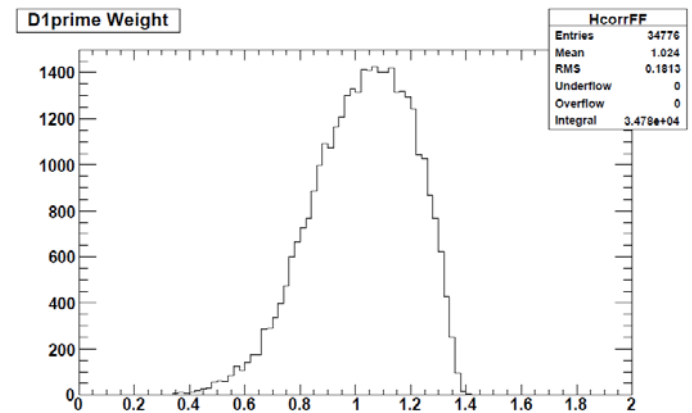
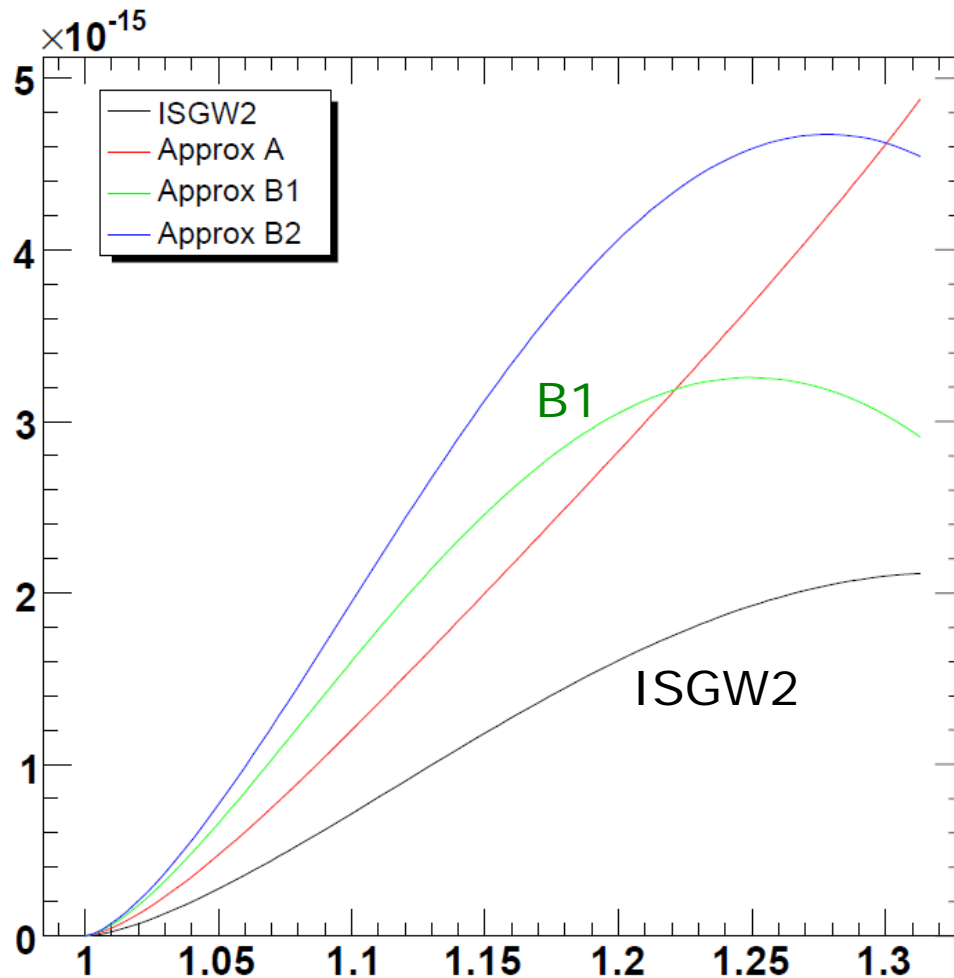
$$R_N = 0.749$$

D_0^* $d\Gamma/dw$ and Weights



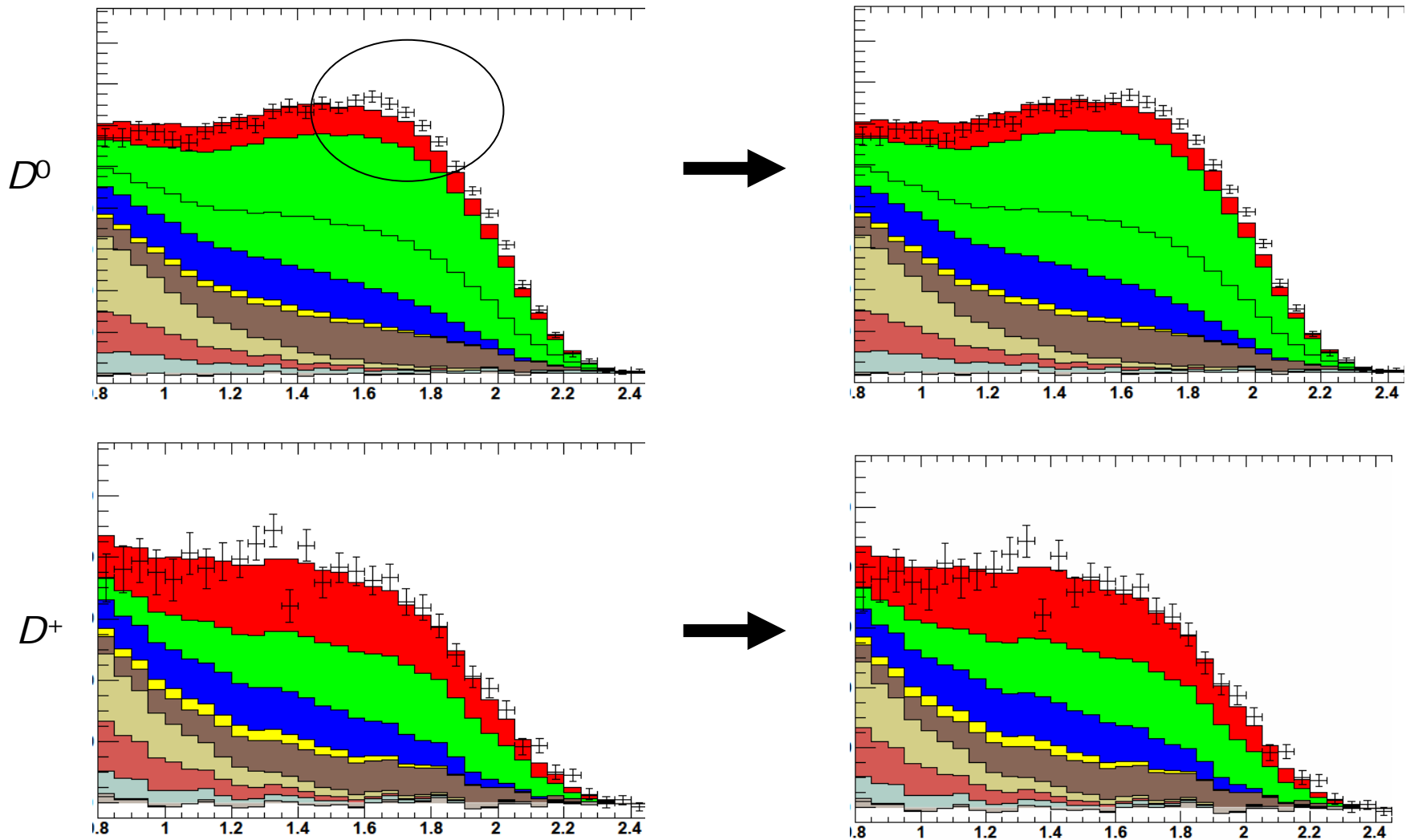
$$R_N = 0.162$$

D_1' d Γ /dw and Weights



$$R_N = 0.549$$

$P_i: D^{*+} \text{ FF re-weighting}$

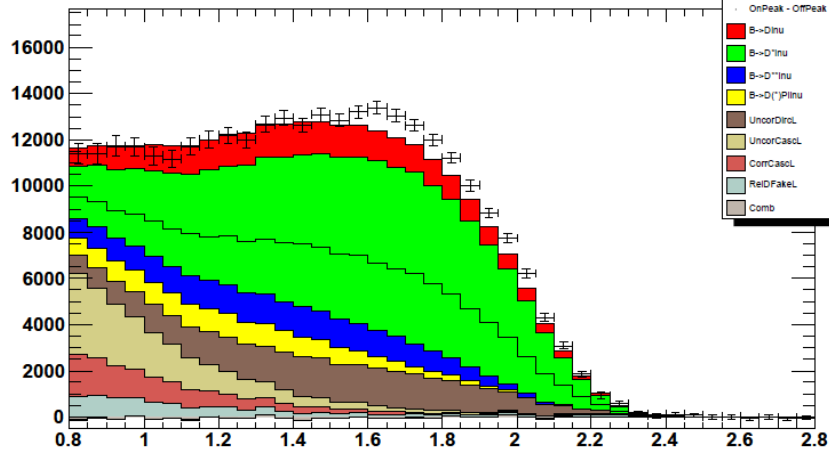


Summary

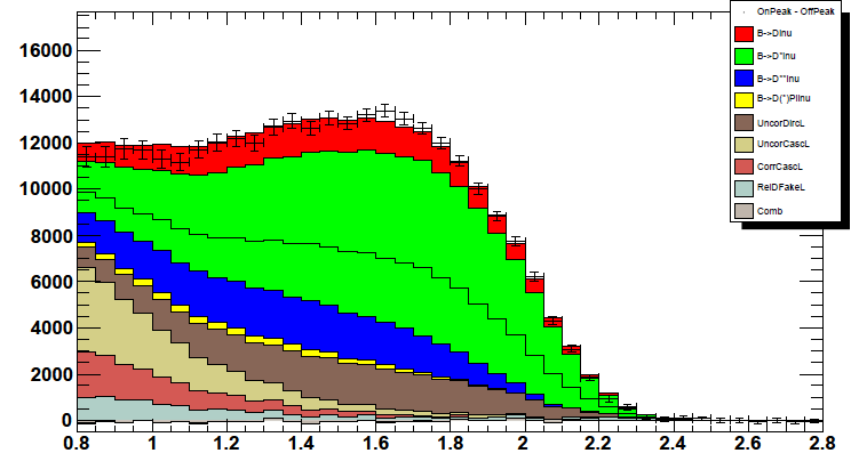
- Background BF re-weighting is done.
- $B \rightarrow D^{*+} \ell \nu$ FF re-weighting is done.
- Better agreement between MC and data
- Next steps
 - Fit validation
 - Perform fitting
 - Systematic study
 - BAD1586 V2

Lepton Momentum

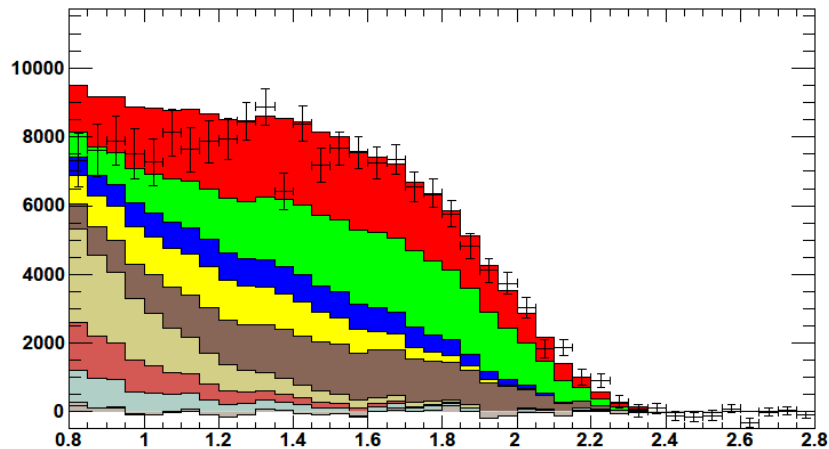
Lepton momentum (D0)



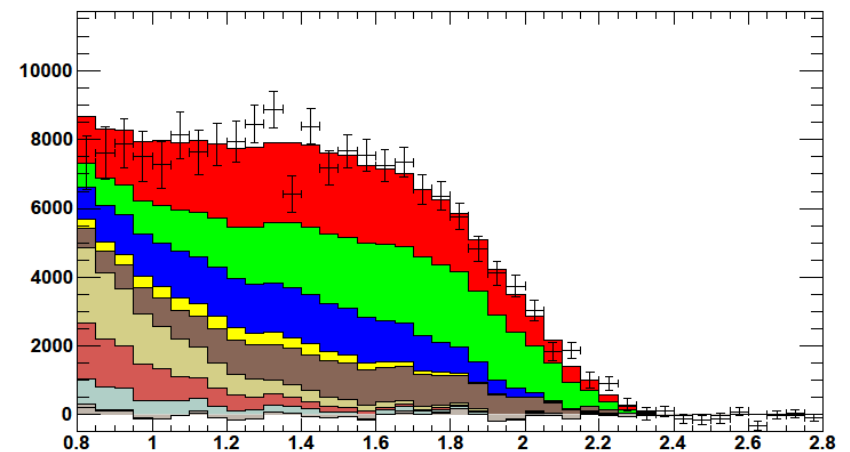
Lepton momentum (D0)



Lepton momentum (D+)

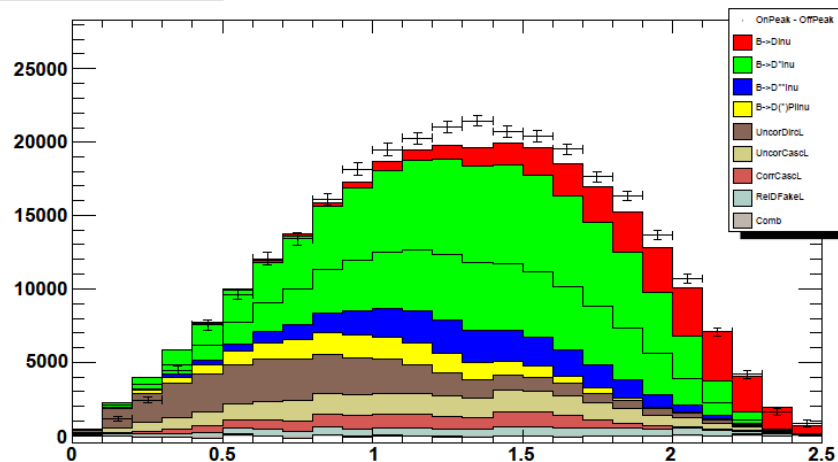


Lepton momentum (D+)

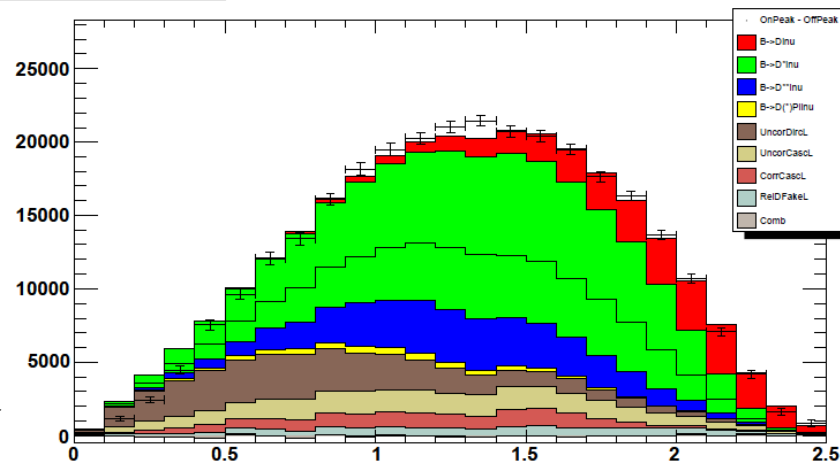


D Momentum

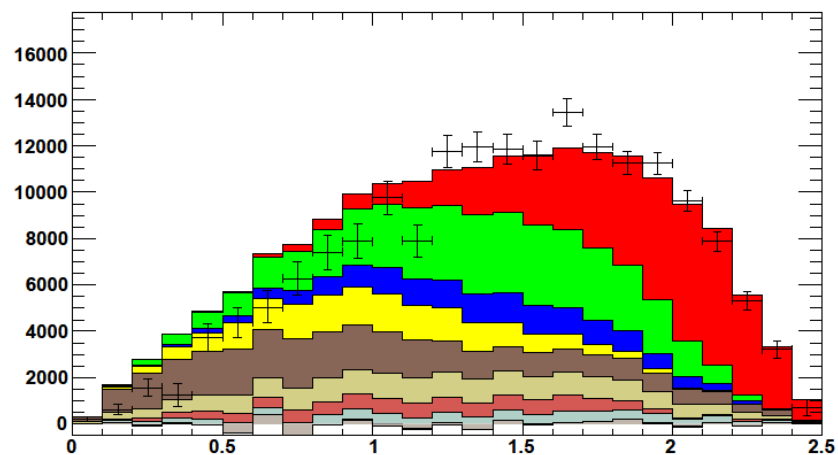
D momentum (D0)



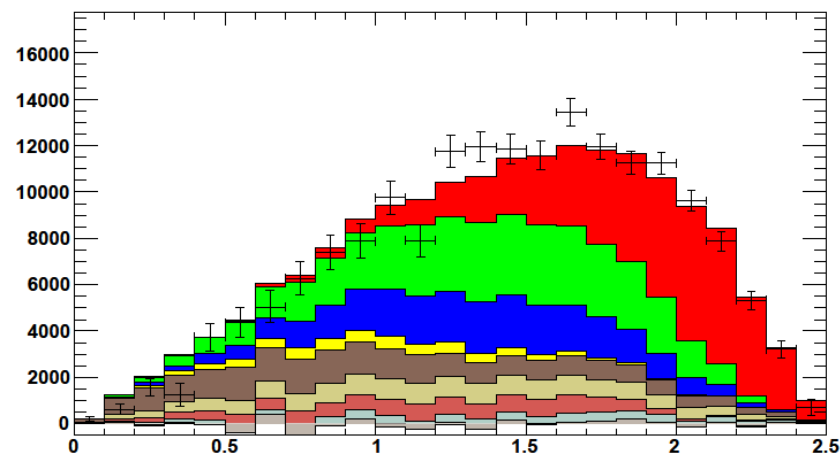
D momentum (D0)



D momentum (D+)

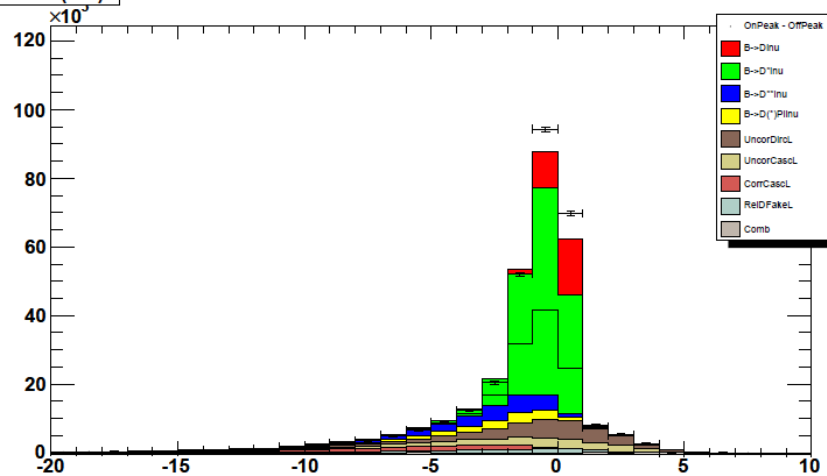


D momentum (D+)

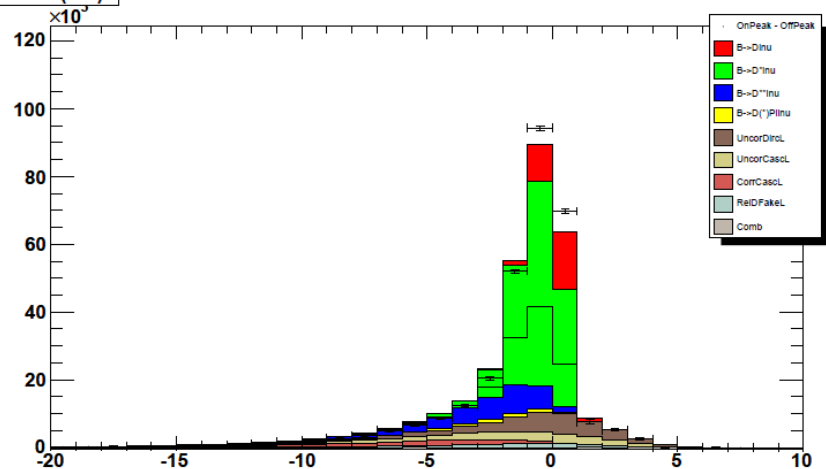


cosBY

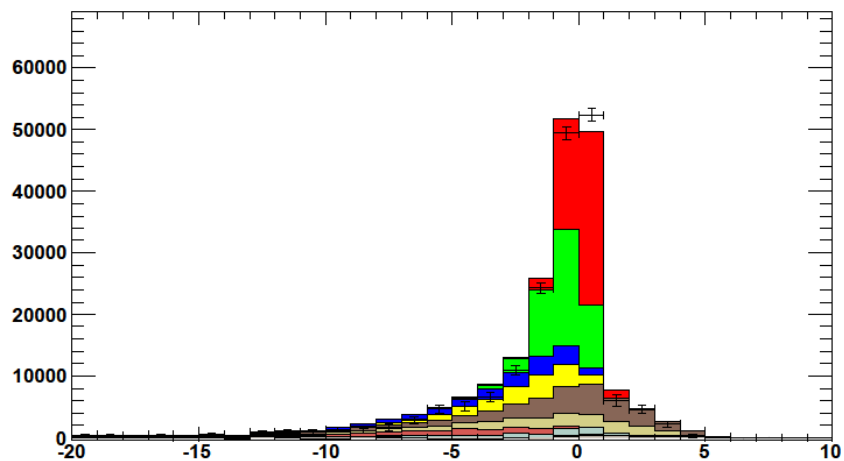
cosBY (D0)



cosBY (D0)



cosBY (D+)



cosBY (D+)

