Backup Slides

Moments Correlations

	Stat	Stat+Exp+BR	Stat+Exp+BR+Theo
m	74%	48% (no BR)	-
M	92%	62%	-
Λ	-99%	-88%	-77%

V_{cb}: exclusive determination

- Measure absolute scale of $B \rightarrow D^* l \nu$
- D^{**} states also important for $|V_{cb}|$ exclusive determination
  - end-point in q^2 for $B \rightarrow D^* l \nu$ decays
  - systematic uncertainty from $B \rightarrow D^{**} l \nu$ background

Channels with neutral B

- $\underline{B^0} \rightarrow D^{**+}\, l^- \,\underline{\nu}$
  - $D^{**+} \rightarrow D^0 \pi^+$ OK
  - $D^{**+} \rightarrow D^+ \pi^0$ Not reconstructed. Half the rate of $D^+ \pi^-$
  - $D^{**+} \rightarrow D^{*0} \pi^+$
    - $D^{*0} \rightarrow D^0 \pi^0$ Not reconstructed. Background to $D^0 \pi^+$
    - $D^{*0} \rightarrow D^0 \gamma$ Not reconstructed. Background to $D^0 \pi^+$
  - $D^{**+} \rightarrow D^{*+} \pi^0$ Not reconstructed. Half the rate of $D^{*+} \pi^-$

➡ We will not deal with neutral B

Data Stability

A: (152595-154012) Before winter 2003 shutdown

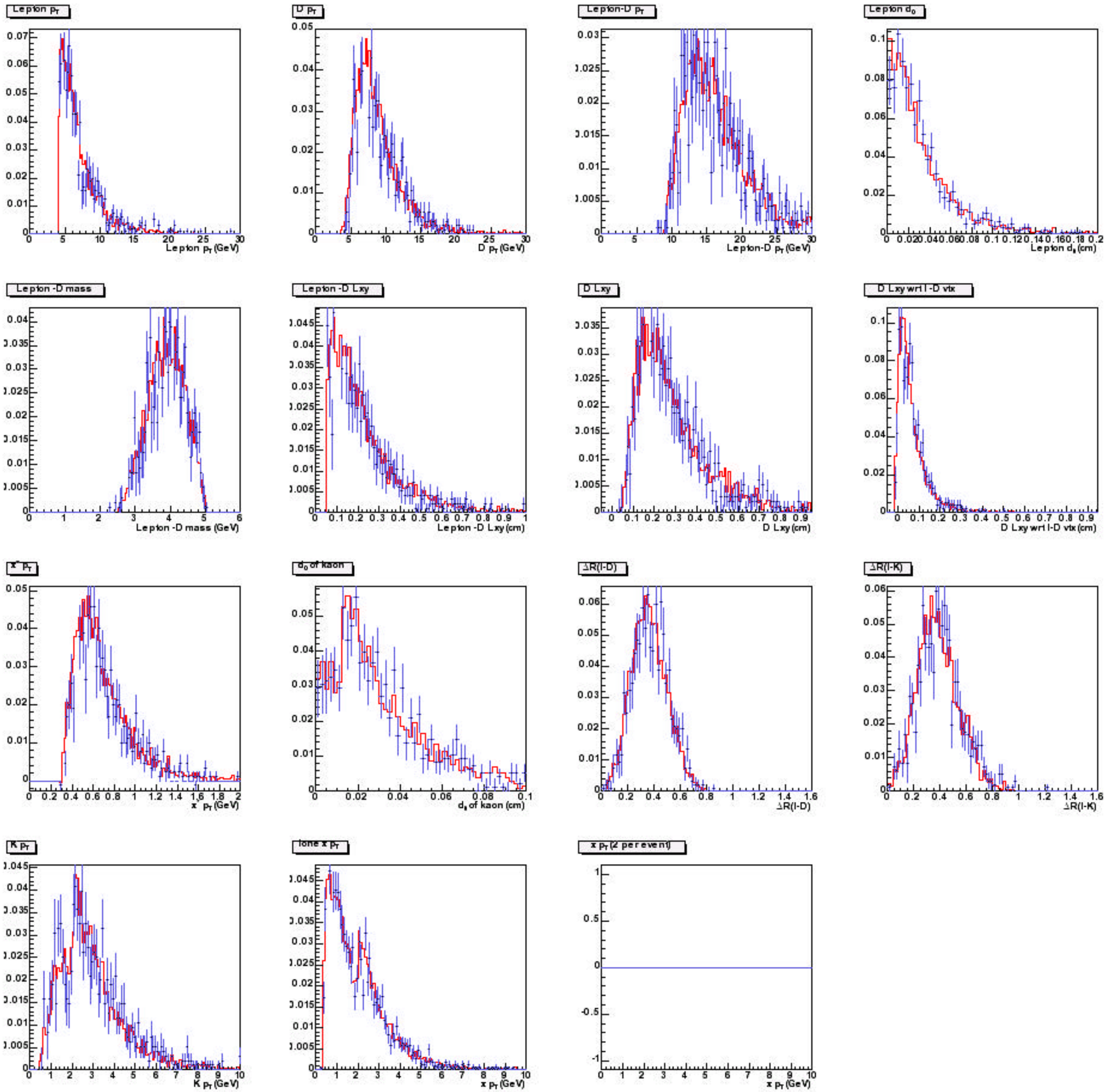
B: (158826-165297) After winter 2003 shutdown

C: (164303-165297) SVT 4/5

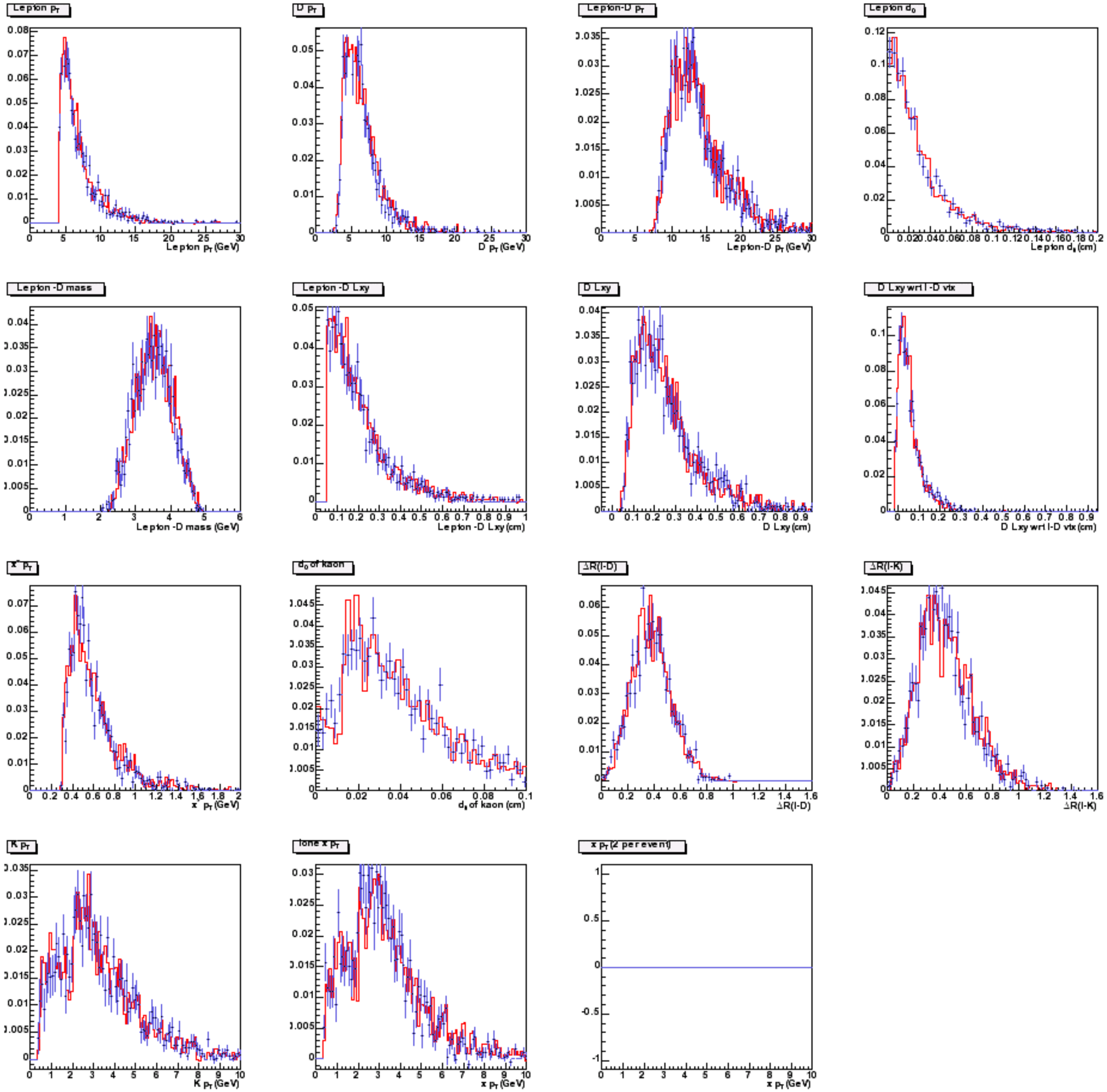
Kinematic variable	$D^0 \to K^-\pi^+$		$D^0 \to K^-\pi^+\pi^0$		$D^0 \to K^-\pi^+\pi^-\pi$		$D^+ \to K^-\pi^+\pi^+$	
	e	μ	e	μ	e	μ	e	μ
$p_T(\ell)$	11	95	34	94	0.9	57	2	78
$p_T(D)$	21	24	5	68	98	88	35	92
$p_T(\ell D)$	4	8	23	40	89	8	39	13
$d_0(\ell)$	6	58	77	88	94	3	18	98
$m(\ell D)$	33	20	4	51	5	57	46	6
$L_{xy}(\ell D)$	76	78	28	97	78	26	24	58
$L_{xy}(D)$	58	96	23	9	69	51	96	62
$L_{xy}(D \text{ to } \ell D)$	48	3	30	15	3	53	78	45
$p_T(\pi^*) > 0.4$ GeV	0.2	33	41	21	71	92		
$d_0(K)$	28	82	20	92	32	68	29	46
$\Delta R(\ell D)$	38	0.9	30	95	7	13	21	92
$\Delta R(\ell K)$	54	46	44	18	83	14	24	30
$p_T(K)$	51	33	76	26	15	30	28	33
lone π p_T	77	58	64	33	54	19		
π p_T (2 per event)							90	25

Table 3: Matching χ^2 probability (in %) between the periods A+B and period C in data for several kinematic variables and for the different channels.

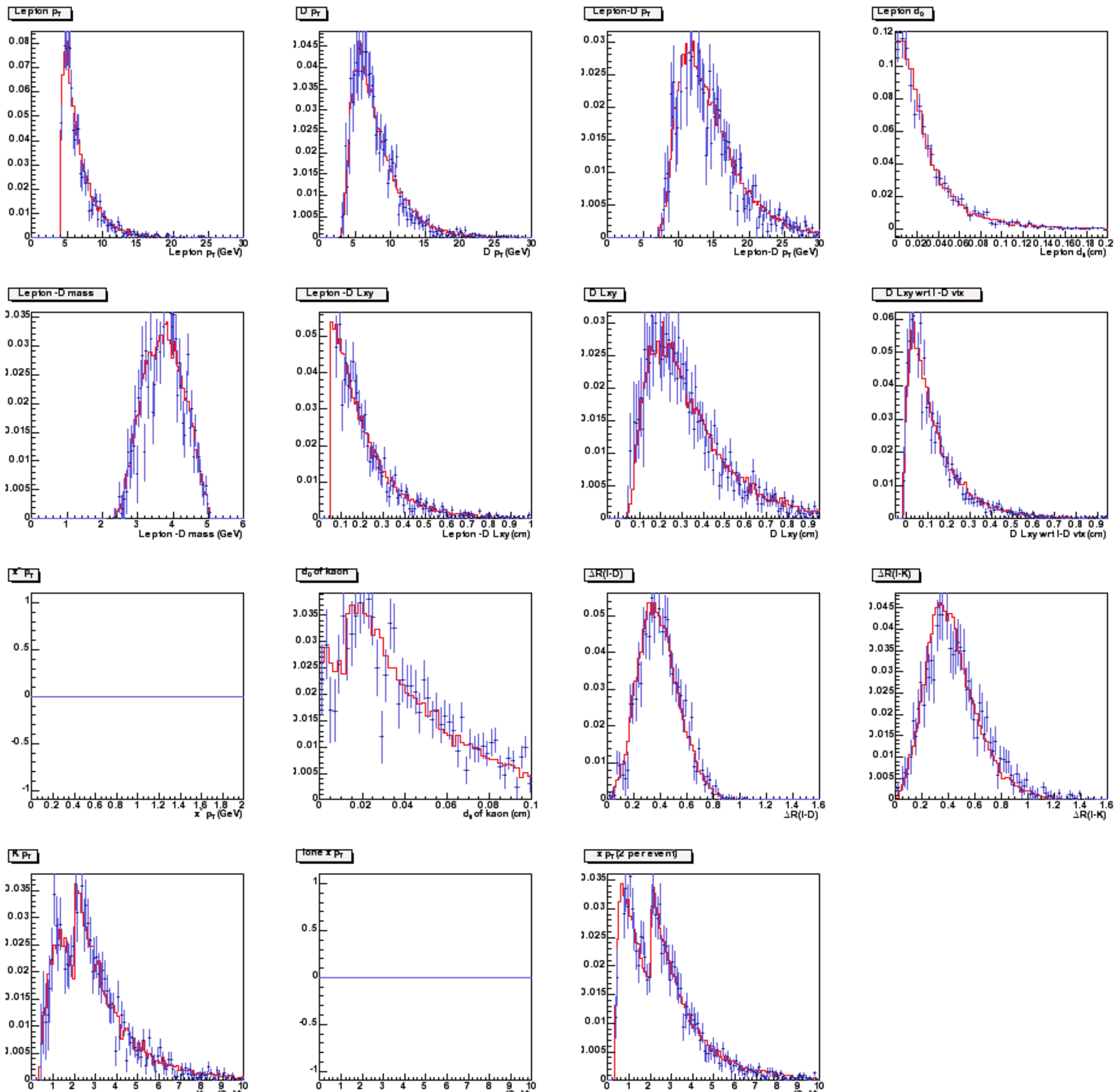
Kinematic Comparisons lD*, $D^0 \to K\pi\pi\pi$



Kinematic Comparisons ID*, $D^0 \to K\pi\pi^0$



Kinematic Comparisons: D^+



Can we "predict" yields?

$$R_{D+/K\pi} \equiv \frac{N(B \to D^+ l\bar{\nu}X, D^+ \to K^-\pi^+\pi^+)}{N(B \to D^{*+} l\bar{\nu}X, D^{*+} \to D^0\pi^+, D^0 \to K^-\pi^+)},$$

$$R_{K3\pi/K\pi} \equiv \frac{N(D^{*+} l\bar{\nu}X, D^{*+} \to D^0\pi^+, D^0 \to K^-\pi^+\pi^-\pi^+)}{N(D^{*+} l\bar{\nu}X, D^{*+} \to D^0\pi^+, D^0 \to K^-\pi^+)}.$$

Two methods (a,b) to derive this BR

a) Based on inclusive $b \to D^{(*)+} l\nu$

b) Based on exclusive $B \to D^{(*)+} l\nu$, $D^{**} l\nu$

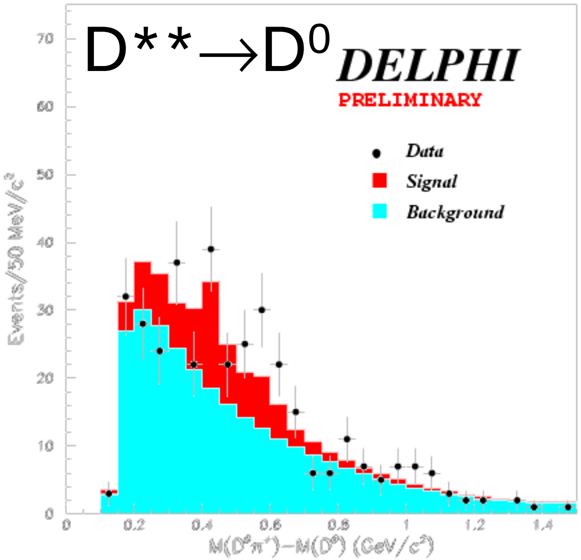
+PDG BR + MC efficiency ratios

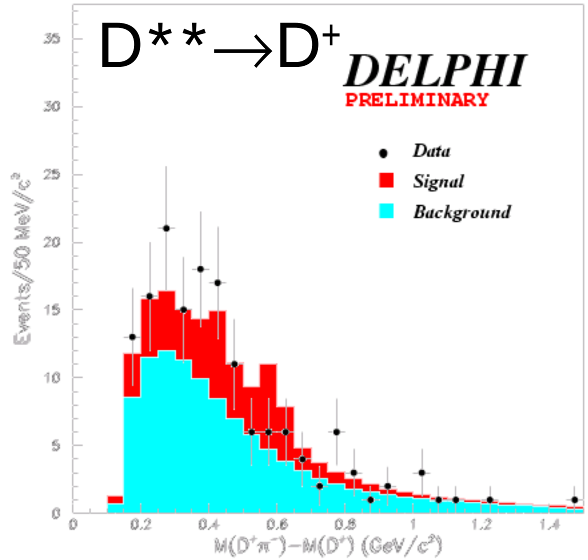
	$R_{pred.}$	R_{data}	$R_{pred.}/R_{data}$
$R_{D+/K\pi}$			
data (sans D_s)		3.71 ± 0.08	
Method (a)	3.31 ± 0.58		0.89 ± 0.16
Method (b)	$3.23 \pm 0.29 \pm ?$		$0.87 \pm 0.08 \pm ?$
$R_{K3\pi/K\pi}$			
data		0.77 ± 0.02	
	0.80 ± 0.04		1.04 ± 0.06

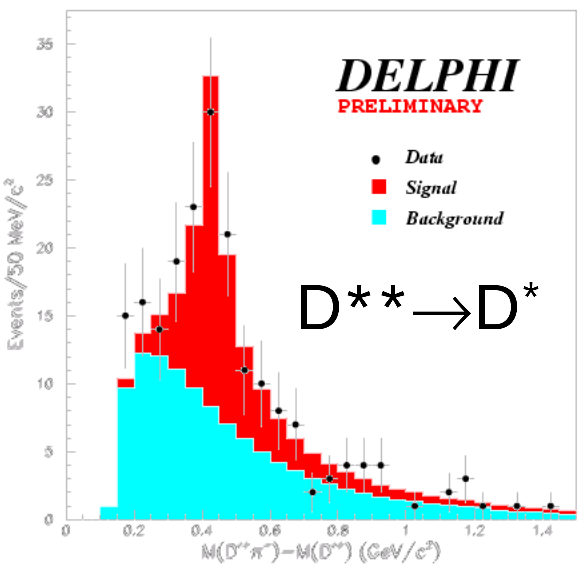
What background model for what?

- WS is often used in this kind of analyses as a model for the background
- We can also use our fully reco'd B from other triggers
- We choose to use WS for the optimization
- Embedding is being used as a cross-check for systematics

What's available on the market…



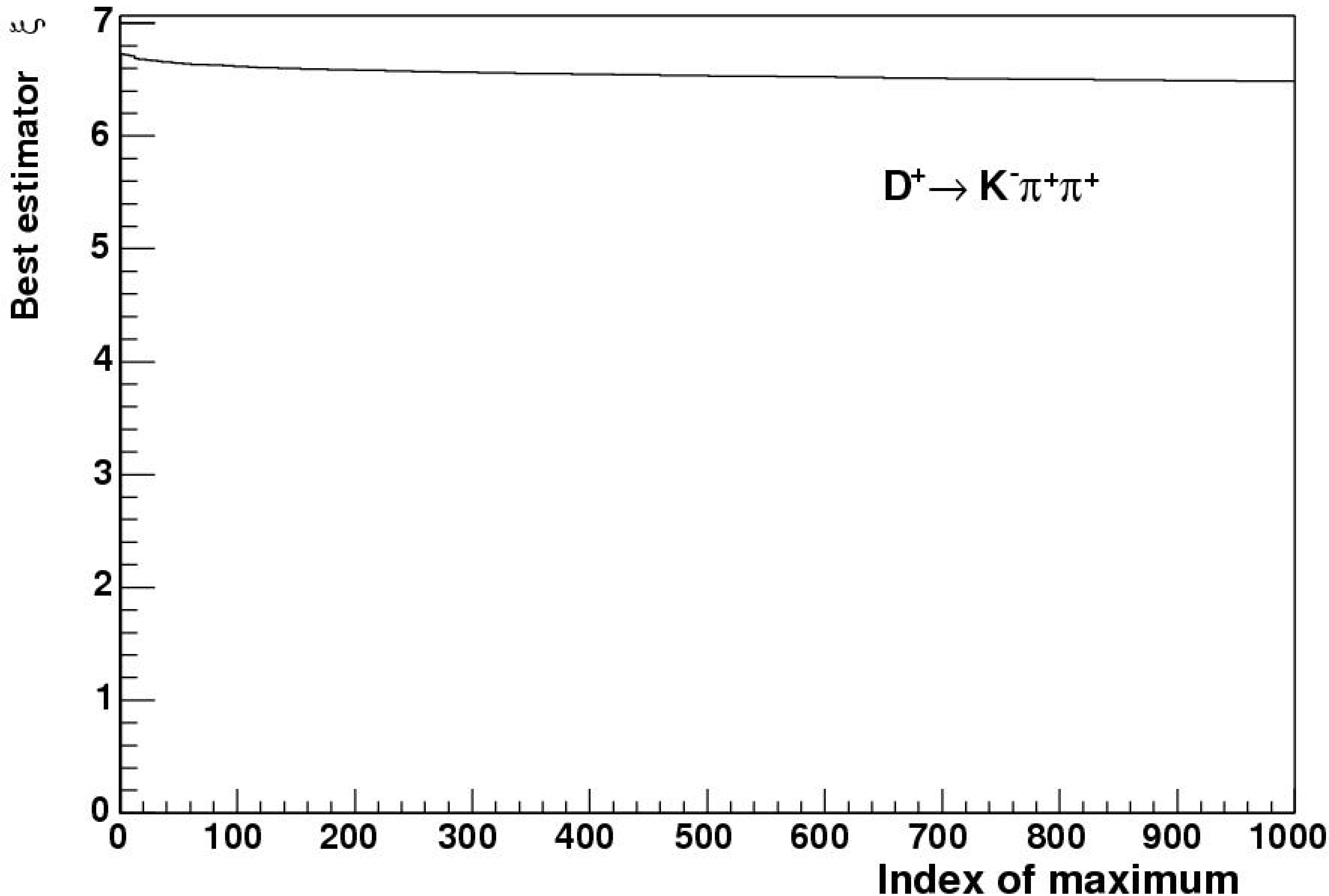




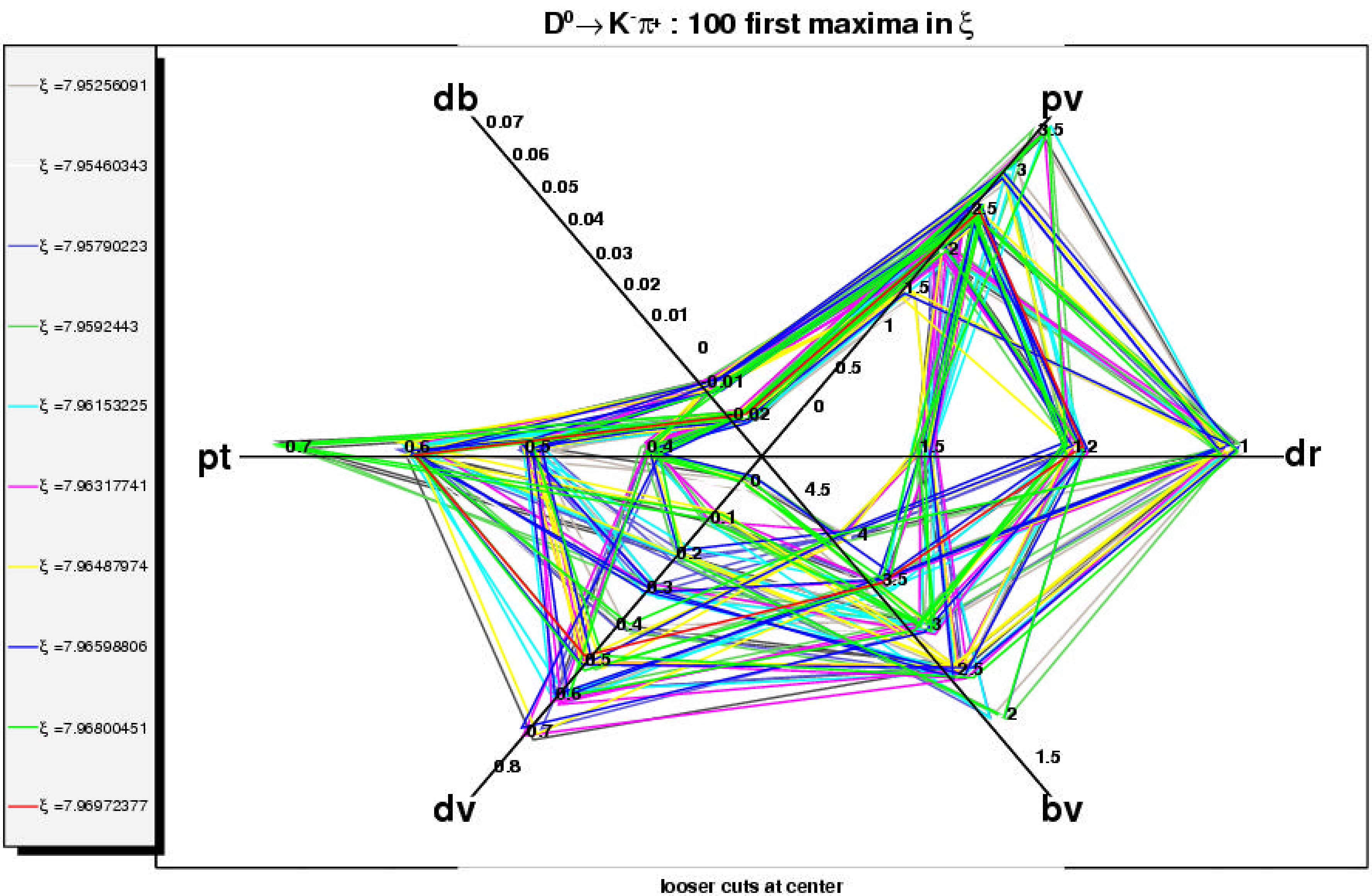
- No background subtraction
- ~80 events in D^{*+}
- ~80 events in D^{+}
- ~215 events on D^{0}

uncertainty > sqrt(n)

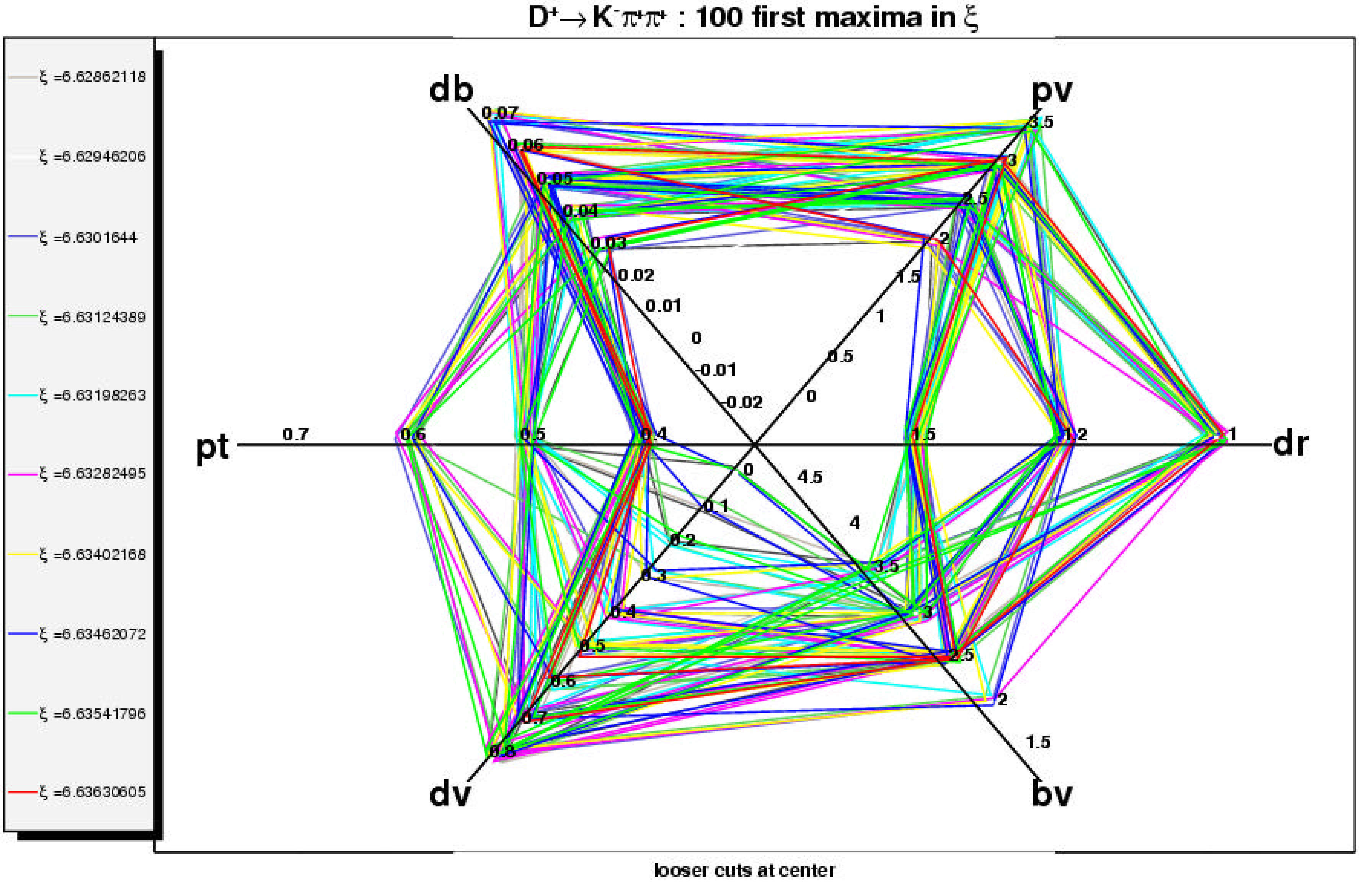
Estimator Behaviour



Kπ Optimization

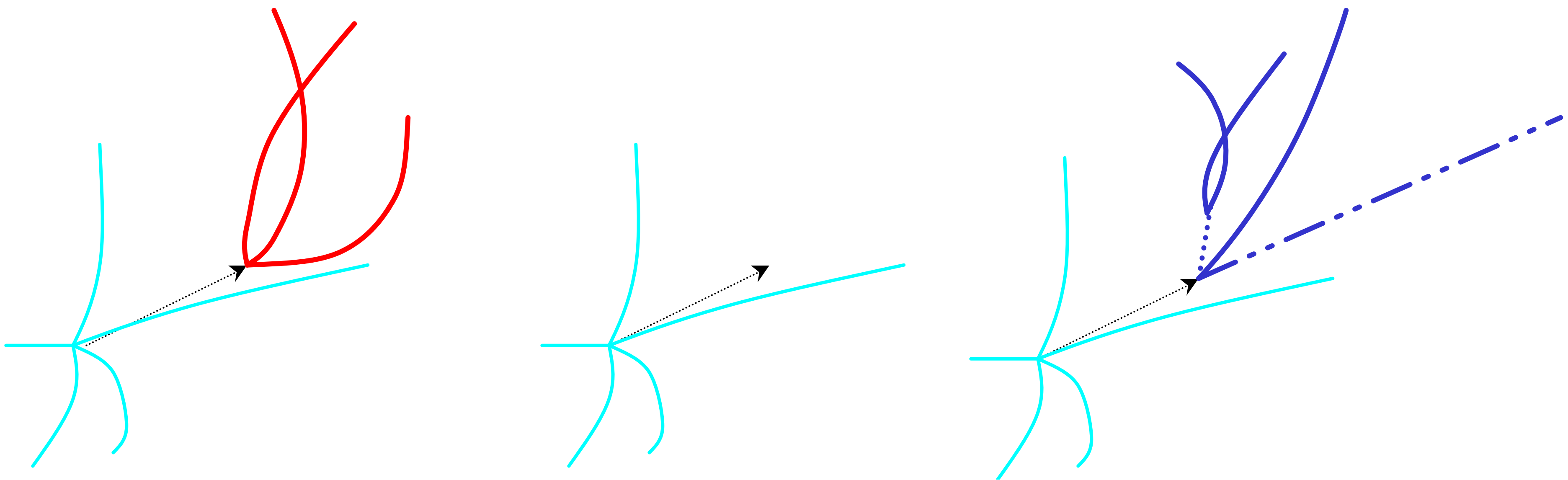


D^+ Optimization



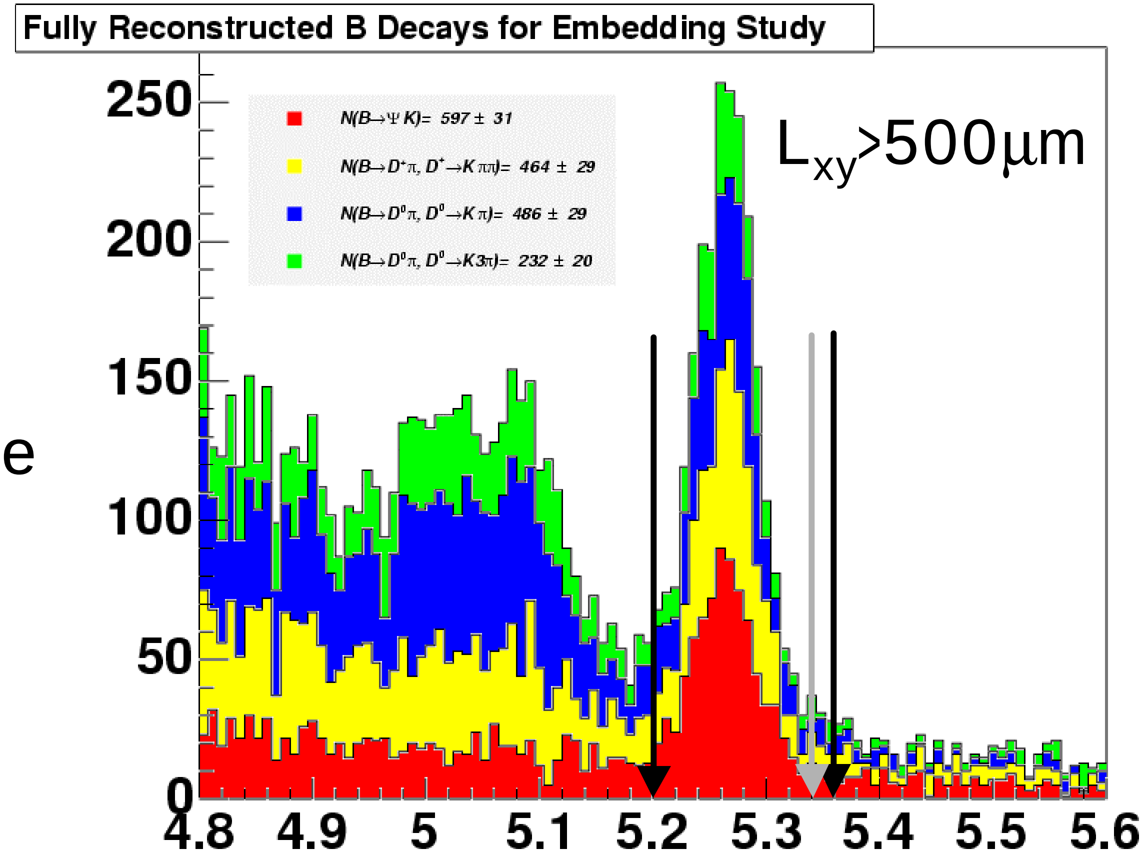
Combinatorial Background

- WS π^{**}
  - Already used for the optimization
  - Physics can be different
- Fully reco. B
  - independent emulation of the background
  - Limited statistics
  - Needs some machinery for emulating a semileptonic decay!
    - Eliminate the B daughters
    - Replace the B with a semileptonic B with the same 4-momentum: a template montecarlo where the B decay comes from EvtGen and the rest of the event comes from the data!

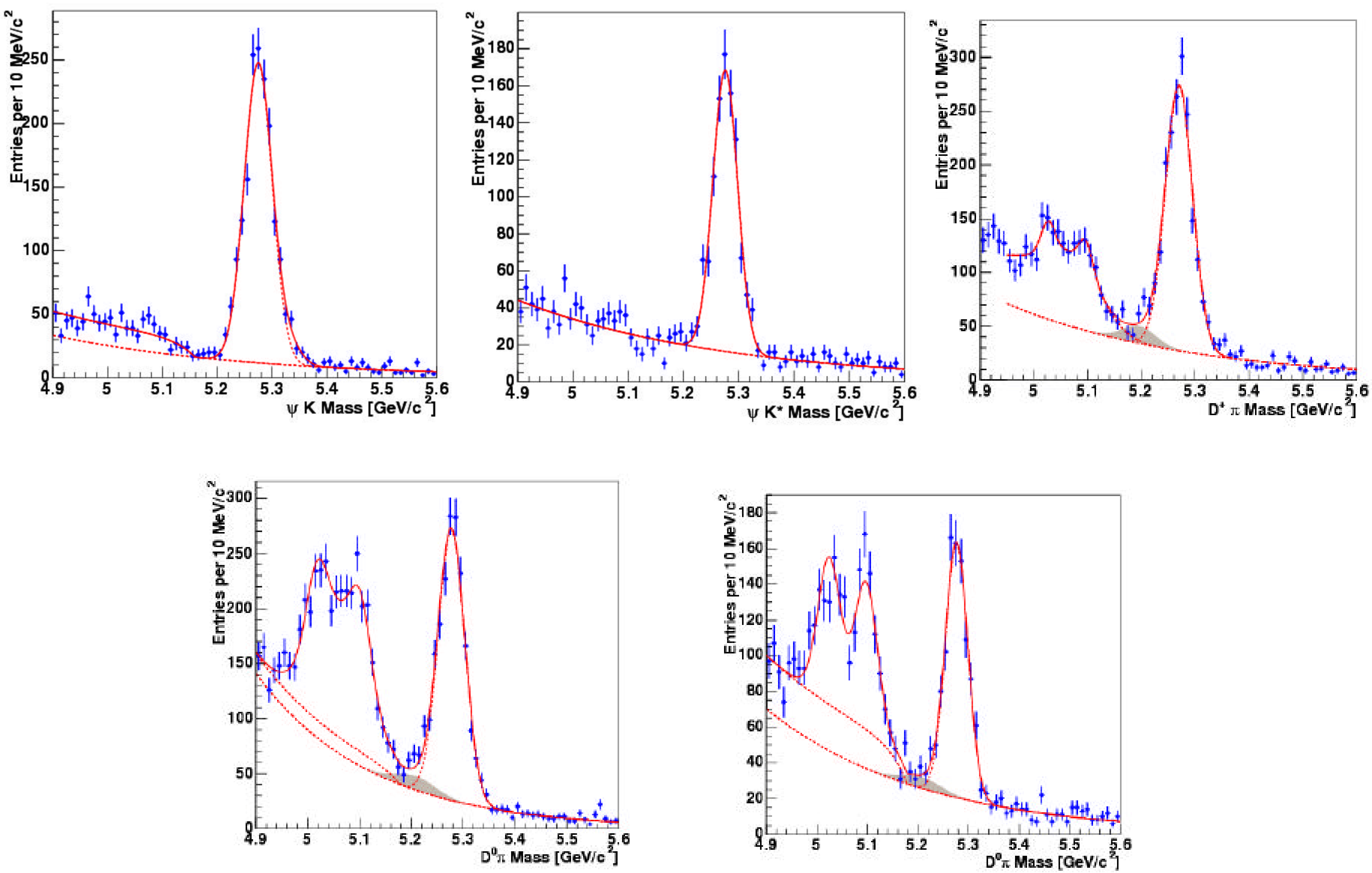


Background Modeling II

- Tight cuts (avoid subtractions)
- Exclude B tracks
- Replace with MC B
- QuickCdfObjects/GenTrig
- Re-decay N times
- Same analysis path from there on



Signal Fits



Entries per 10 MeV/c^2
ψ K Mass [GeV/c^2]
ψ K* Mass [GeV/c^2]
D* π Mass [GeV/c^2]
D^{0}π Mass [GeV/c^2]
D^{0}π Mass [GeV/c^2]

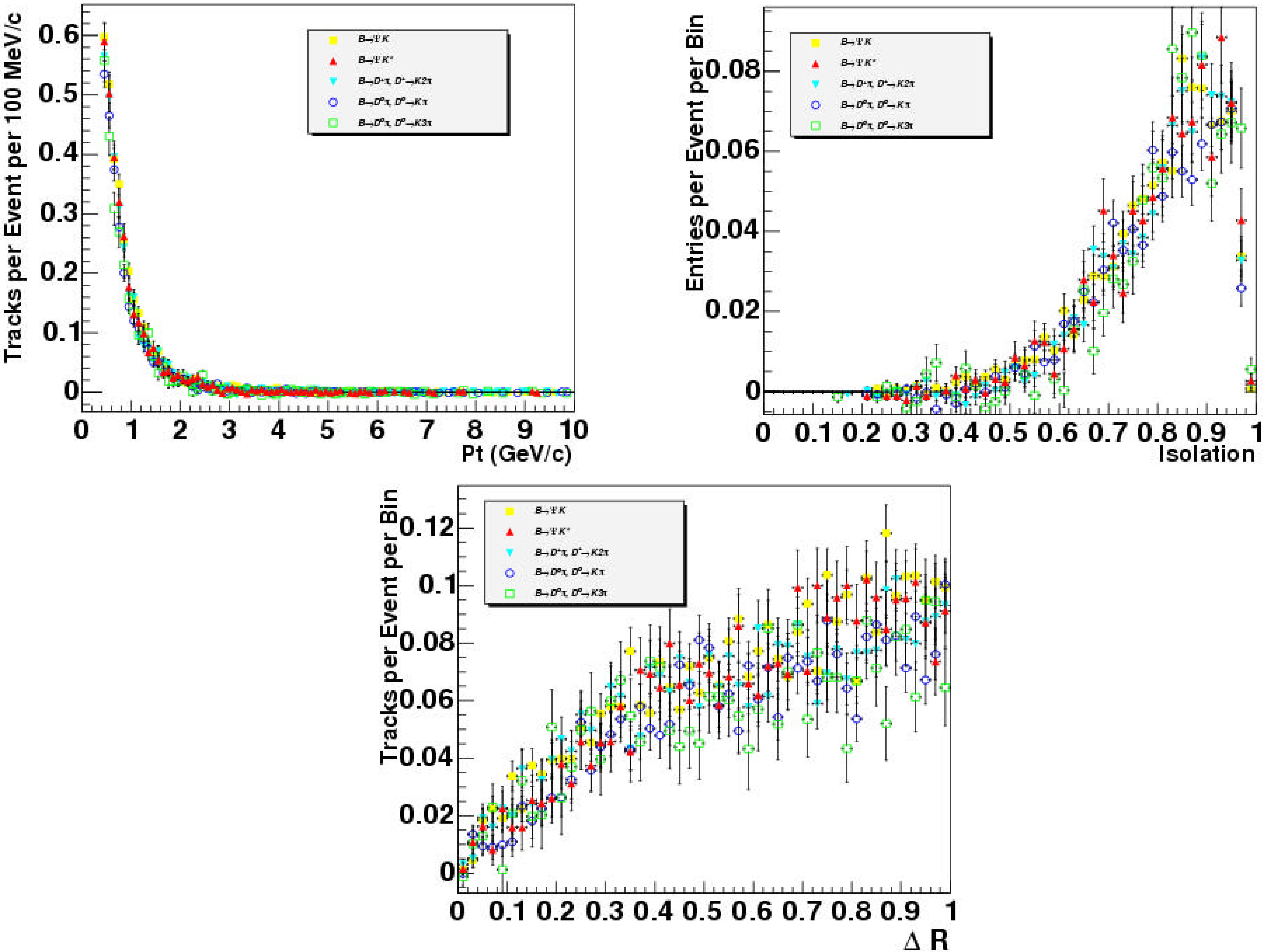
Sample Consistency

	$B^+ \to \psi K^+$	$B^+ \to D^0\pi^+$ $D^0 \to K\pi$	$B^+ \to D^0\pi^+$ $D^0 \to K3\pi$	$B^0 \to \psi K^*$	$B^0 \to D^+\pi^-$ $D^+ \to K\pi\pi$
N_{ch}	3.24 ± 0.06	2.78 ± 0.05	2.76 ± 0.05	3.09 ± 0.06	2.90 ± 0.05
N_{ch}^{OS}	1.77 ± 0.04	1.53 ± 0.03	1.56 ± 0.04	1.53 ± 0.04	1.49 ± 0.03
N_{ch}^{SS}	1.47 ± 0.04	1.25 ± 0.03	1.20 ± 0.04	1.56 ± 0.04	1.41 ± 0.03
p_t	0.93 ± 0.01	0.87 ± 0.007	0.85 ± 0.005	0.92 ± 0.01	0.90 ± 0.007
Iso	0.81 ± 0.003	0.81 ± 0.002	0.85 ± 0.002	0.81 ± 0.003	0.82 ± 0.003
ΔR	0.62 ± 0.004	0.62 ± 0.003	0.60 ± 0.004	0.62 ± 0.004	0.60 ± 0.003

Table 1: The average value of various tracking quantities for the 5 samples described in the text. In all cases, tracks are required to have at more than 2 axial silicon hits. Only tracks with $\Delta R < 1.0$ with respect to the B meson are included. Uncertainties quoted here are statistical only.

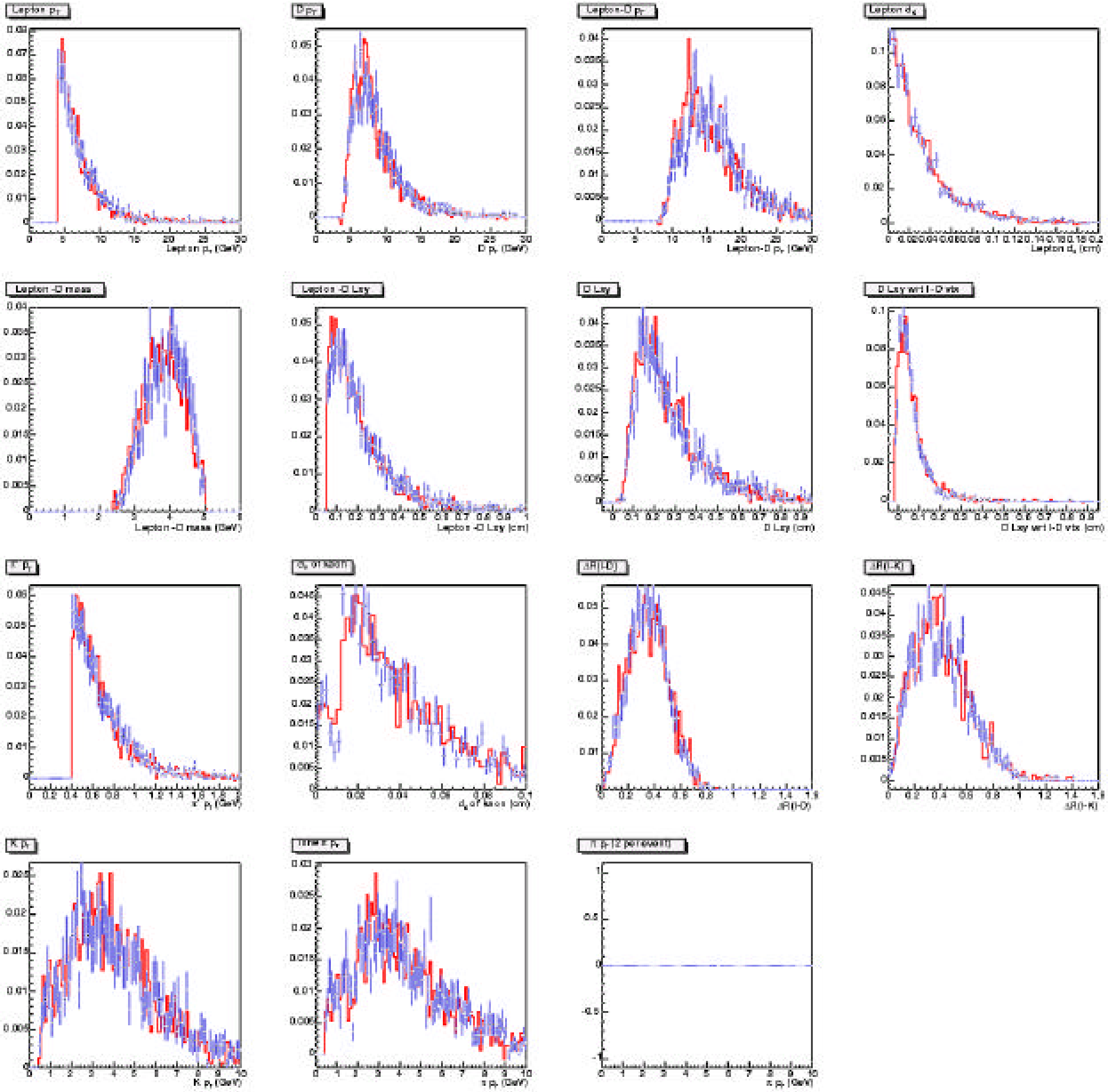
	$B^+ \to \psi K^+$	$B^+ \to D^0\pi^+$ $D^0 \to K\pi$	$B^+ \to D^0\pi^+$ $D^0 \to K3\pi$	$B^0 \to \psi K^*$	$B^0 \to D^+\pi^-$ $D^+ \to K\pi\pi$
N_{ch}	3.35 ± 0.07	3.12 ± 0.05	3.07 ± 0.08	3.17 ± 0.07	3.21 ± 0.05
N_{ch}^{OS}	1.82 ± 0.04	1.72 ± 0.04	1.73 ± 0.05	1.56 ± 0.04	1.67 ± 0.04
N_{ch}^{SS}	1.53 ± 0.04	1.39 ± 0.04	1.34 ± 0.05	1.60 ± 0.04	1.53 ± 0.04
pt	0.95 ± 0.01	0.87 ± 0.008	0.84 ± 0.003	0.90 ± 0.004	0.86 ± 0.007
Iso	0.80 ± 0.004	0.81 ± 0.003	0.84 ± 0.003	0.81 ± 0.004	0.82 ± 0.003
ΔR	0.62 ± 0.004	0.63 ± 0.004	0.60 ± 0.005	0.62 ± 0.005	0.62 ± 0.004

Table 2: The average value of various tracking quantities for the 5 samples described in the text. These results differ from Table 1 in that the pseudorapidity range of the B candidate is now limited to $|\eta_B^{detector}| < 0.6$



Tracks per Event per 100 MeV/c
Pt (GeV/c)
Entries per Event per Bin
Isolation
Tracks per Event per Bin
Δ R
B→ΥK
B→ΥK*
B→D+π, D+→K2π
B→D0π, D0→Kπ
B→D0π, D0→K3π

Embedded MC vs Semileptonics

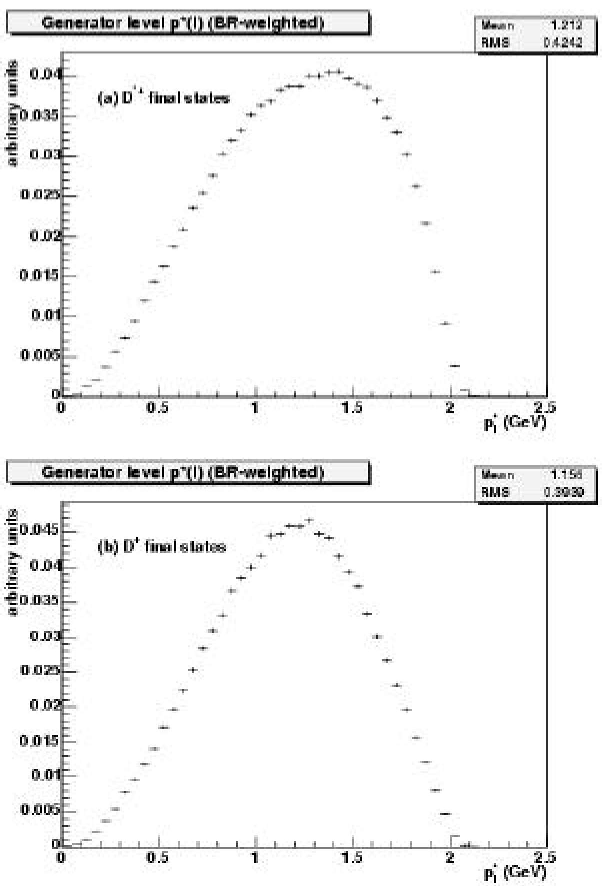


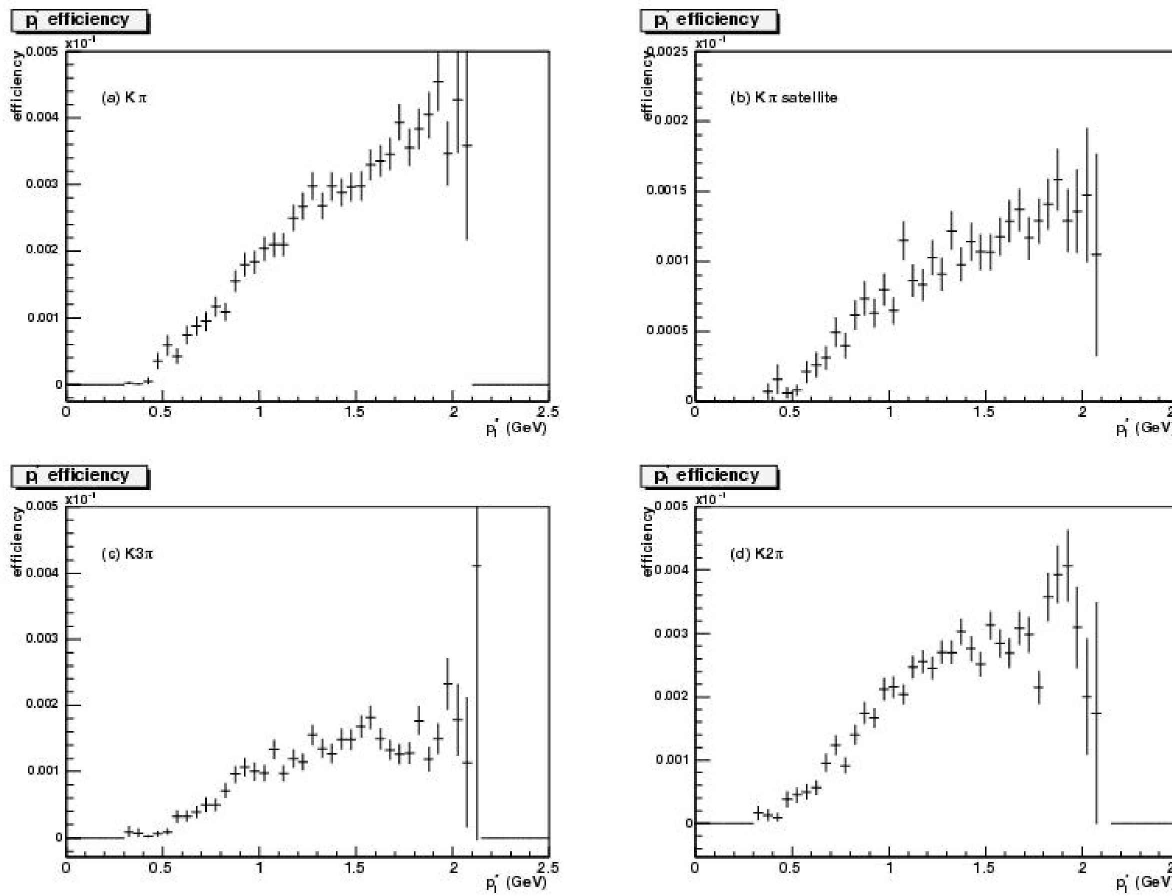
MC yield scaled to number of data events

Kinematic Variable	Probability	χ^2/Dof
$p_T(\ell)$	0.0862432	(37.4921/ 27)
$p_T(D)$	0.00854948	(65.6659/ 41)
$p_T(\ell D)$	0.00287925	(84.576/ 52)
$d_0(\ell)$	0.977983	(9.38652/ 20)
$m(\ell D)$	0.0109354	(79.3892/ 53)
$L_{xy}(\ell D)$	0.961646	(16.2703/ 28)
$L_{xy})(D)$	0.646029	(40.9047/ 45)
$L_{xy}(D\ to\ \ell D)$ vtx	0.109883	(33.9083/ 25)
$p_T(\pi^*)$	0.294054	(39.0136/ 35)
$d_0(K)$	0.562681	(40.9019/ 43)
$\Delta R(\ell D)$	0.151552	(42.4505/ 34)
$\Delta R(\ell K)$	0.0608588	(55.8548/ 41)
$p_T(K)$	0.558166	(53.8112/ 56)
lone π p_T	0.155844	(71.0372/ 60)

P_l*

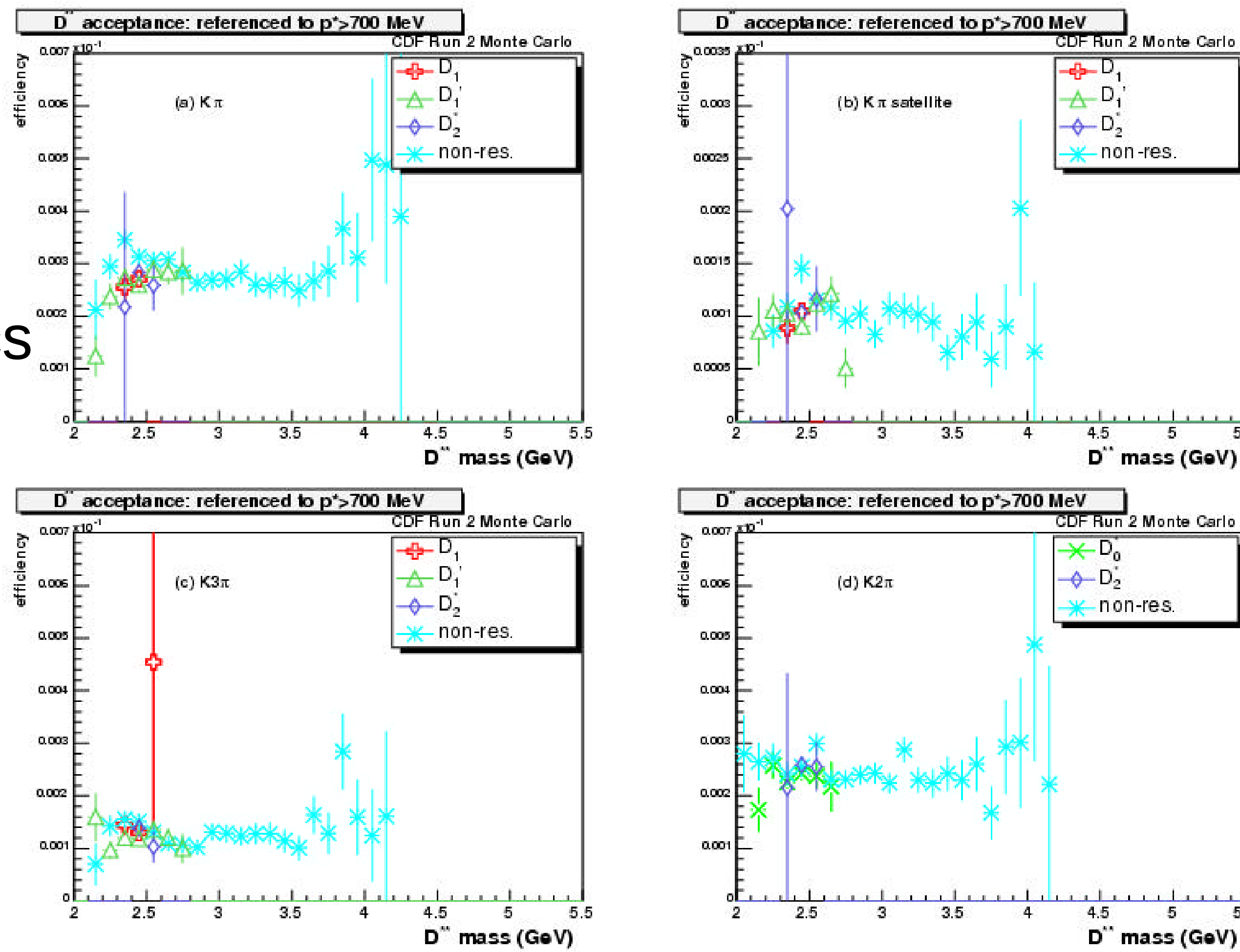
- Theory prediction depends on P_l* cuts. We cannot do much but:
  - see how our analysis bias looks like
  - Use a threshold-like correction
  - Evaluate systematics for different threshold values





MC efficiencies

- $\varepsilon(M)$ is dependent on:
  - D** decay Model
  - P_l* cut
- Use different models/cuts to evaluate systematics



MC Validation

- π^* is an unique probe:
  - Large statistics
  - Low background
  - "Similar" spectrum to π^{**}
  - Can reconstruct with minimal cuts (e.g. COT only)
- Technique:
  - Search for π^* with very loose cuts
  - Do not include in B vertex
  - Study biases to kinematics from tracking
  - Study IP resolution(data/MC): Primary, B & D vertices
  - Study ε(data/MC) vs selection criteria

MC validation

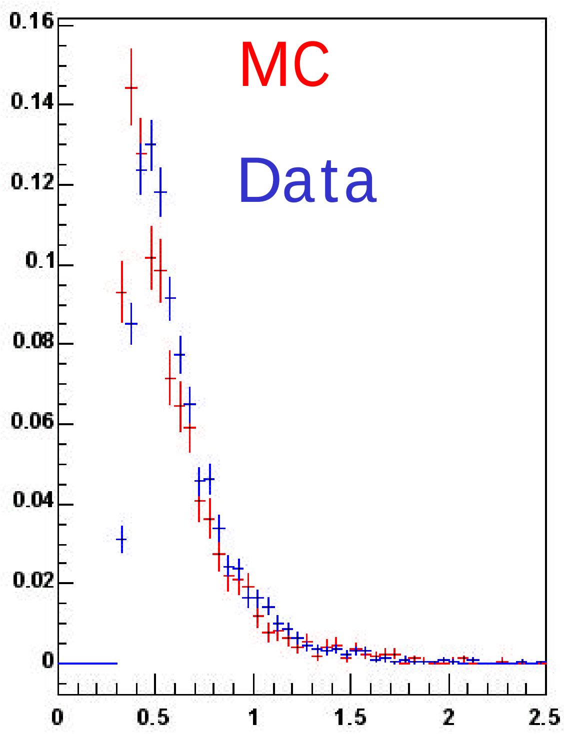
- Cross-check kinematic variables
  - B spectrum modeling
  - Trigger emulation
- Validate CdfSim model of tracking resolution
  - Relative efficiencies
  - π^{**} selection/bias

- Compare many data/MC distributions using binned χ^2
  - Every possible decay mode
  - Sideband subtracted before comparison
  - Duplicate removal ($D^0 \rightarrow K\pi\pi\pi$)

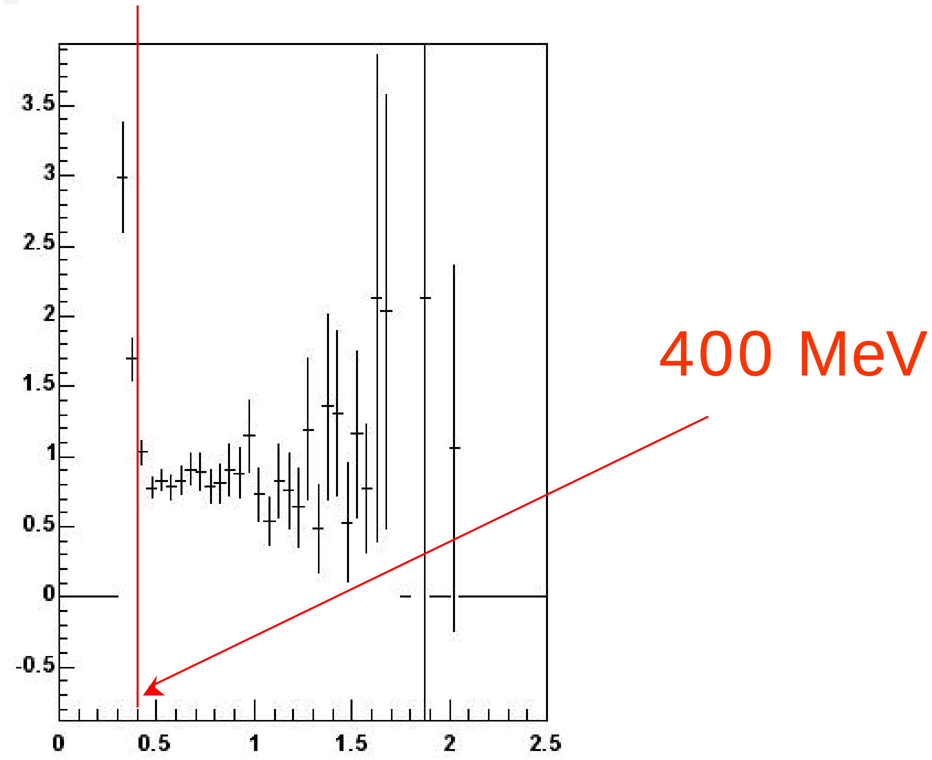
Kinematics

- Can we rely on kinematical biases estimated from MC?
- Rem: we don't care about absolute scales
- Pt dependent MC/data ratio:

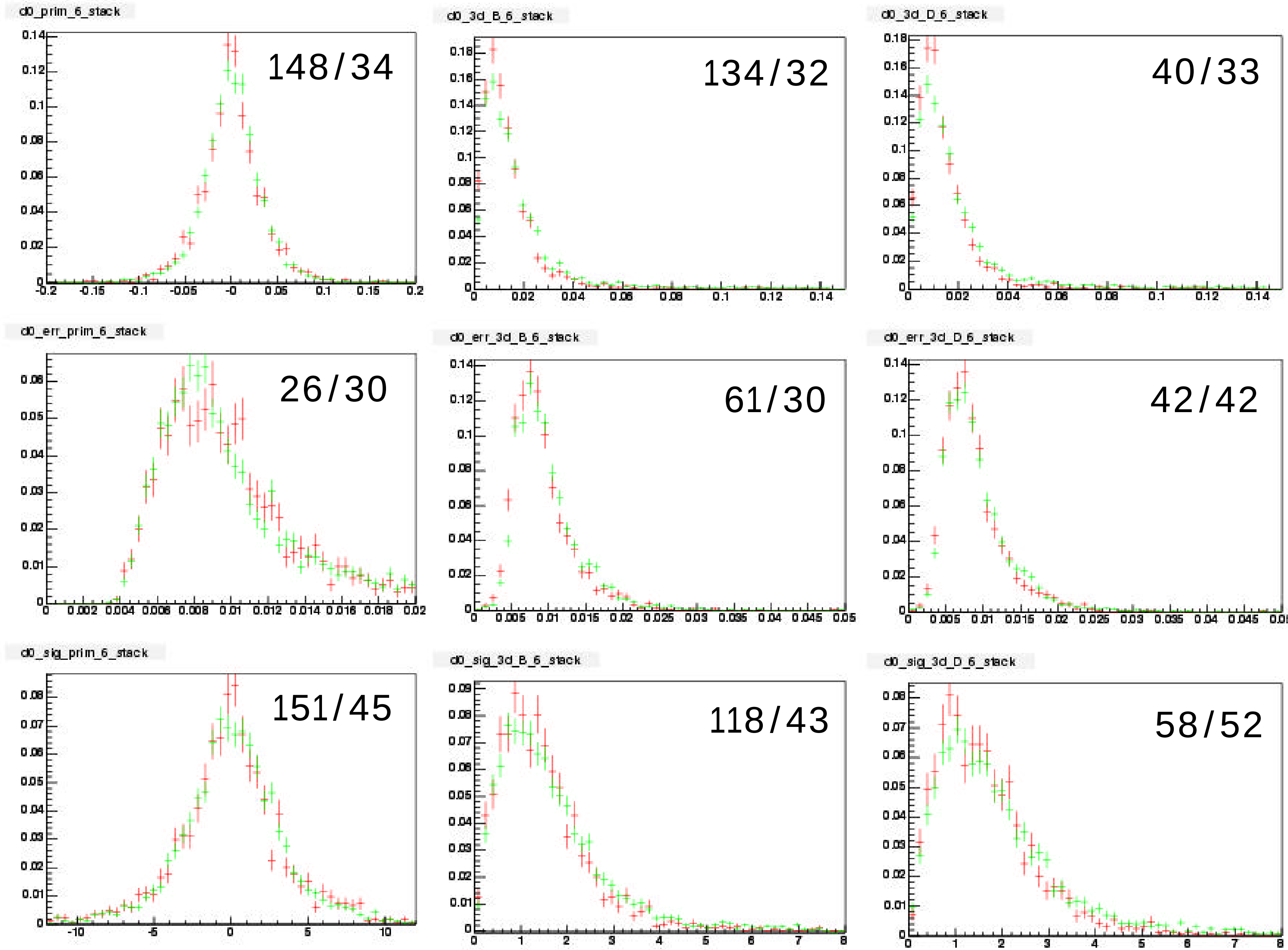
π^* Pt



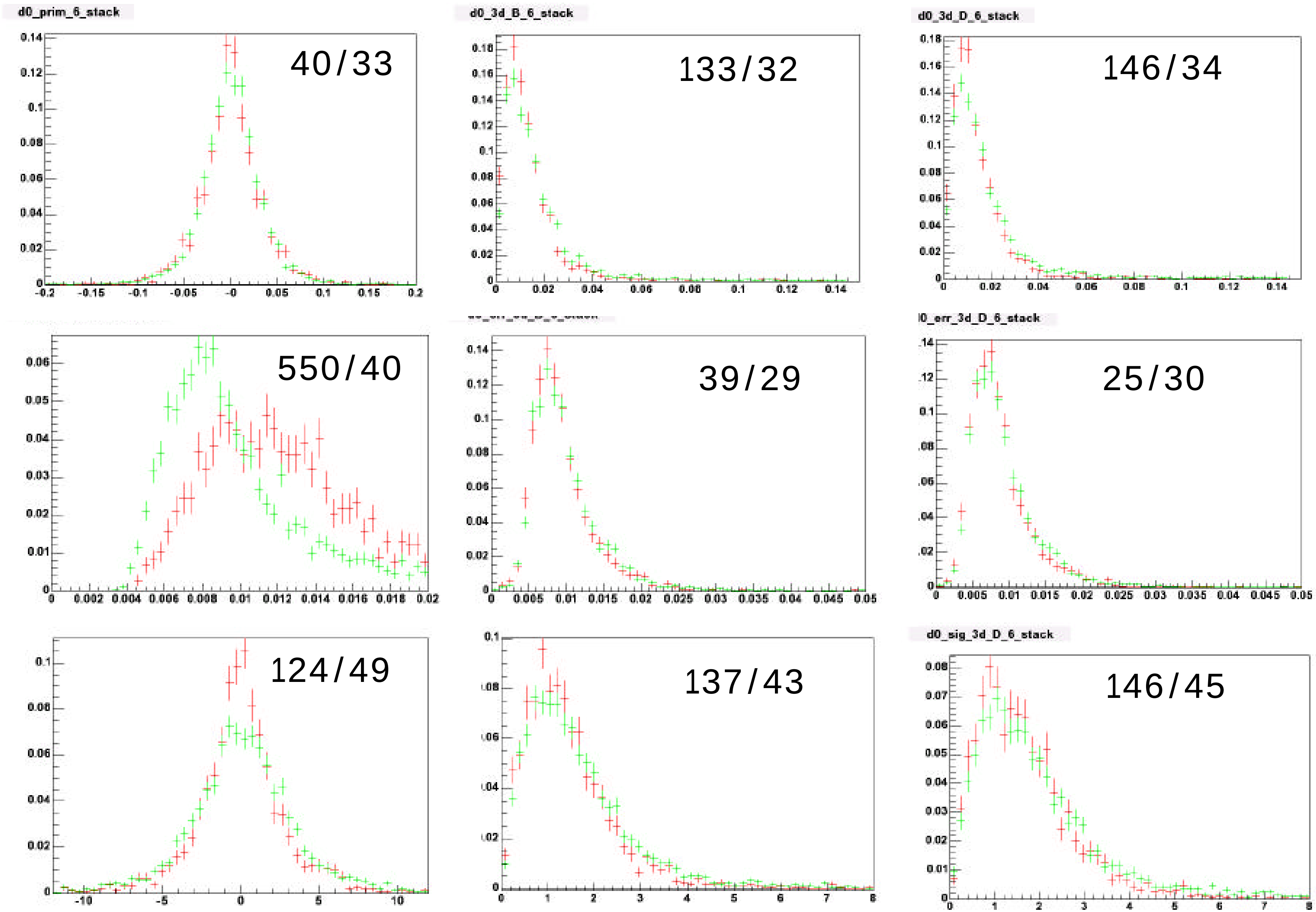
MC/Data vs Pt



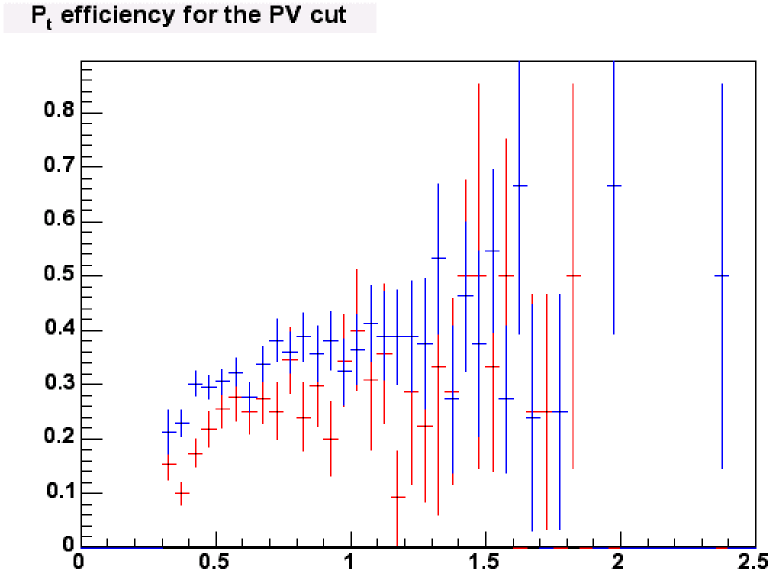
Impact Parameters

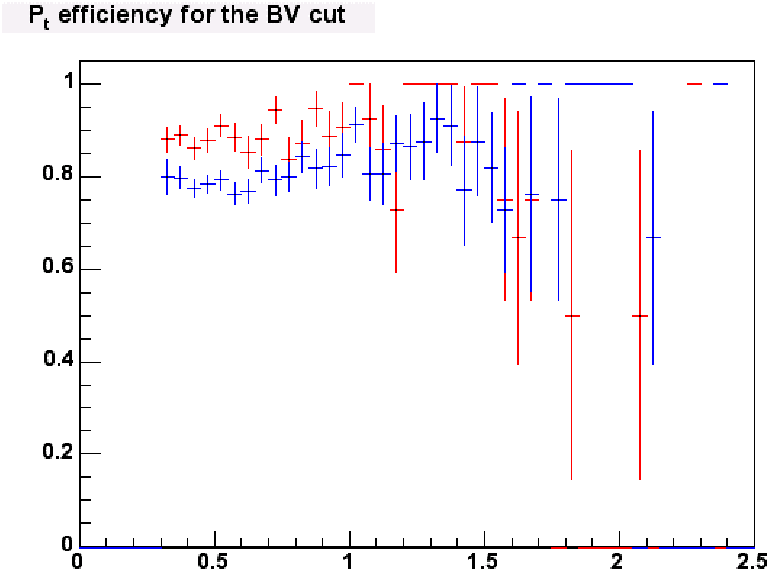


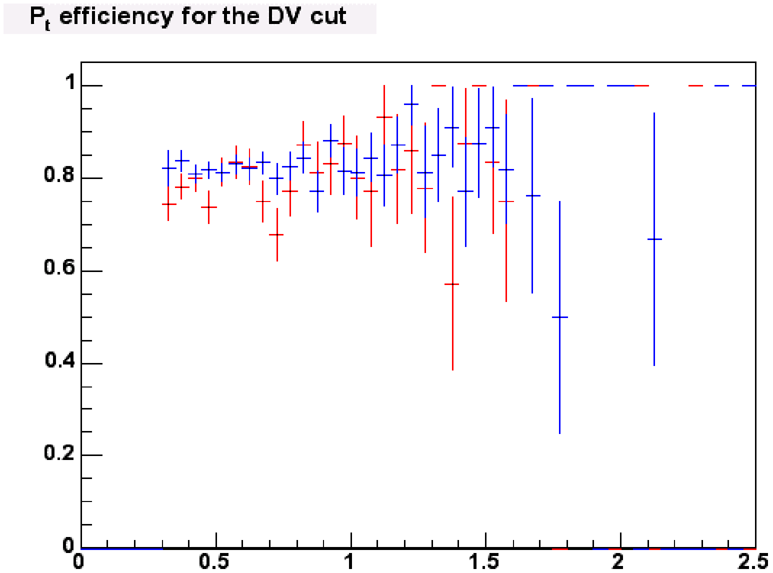
Impact Parameters (covr)

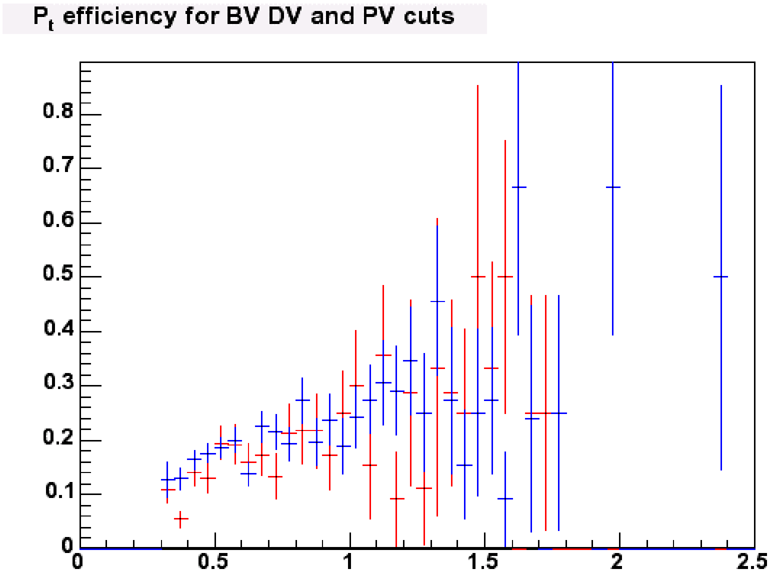


ε(MC), ε(data) vs selection criteria



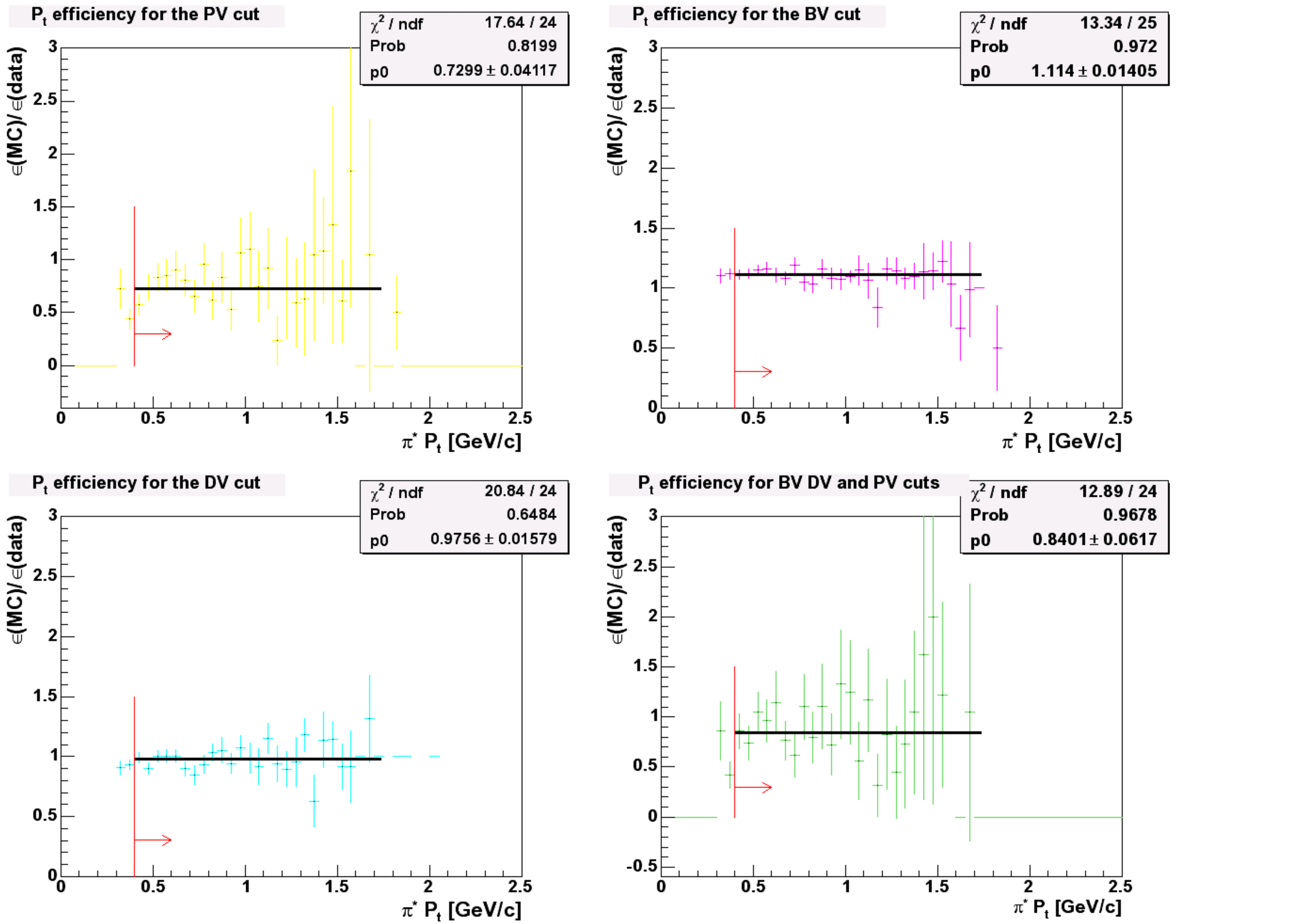




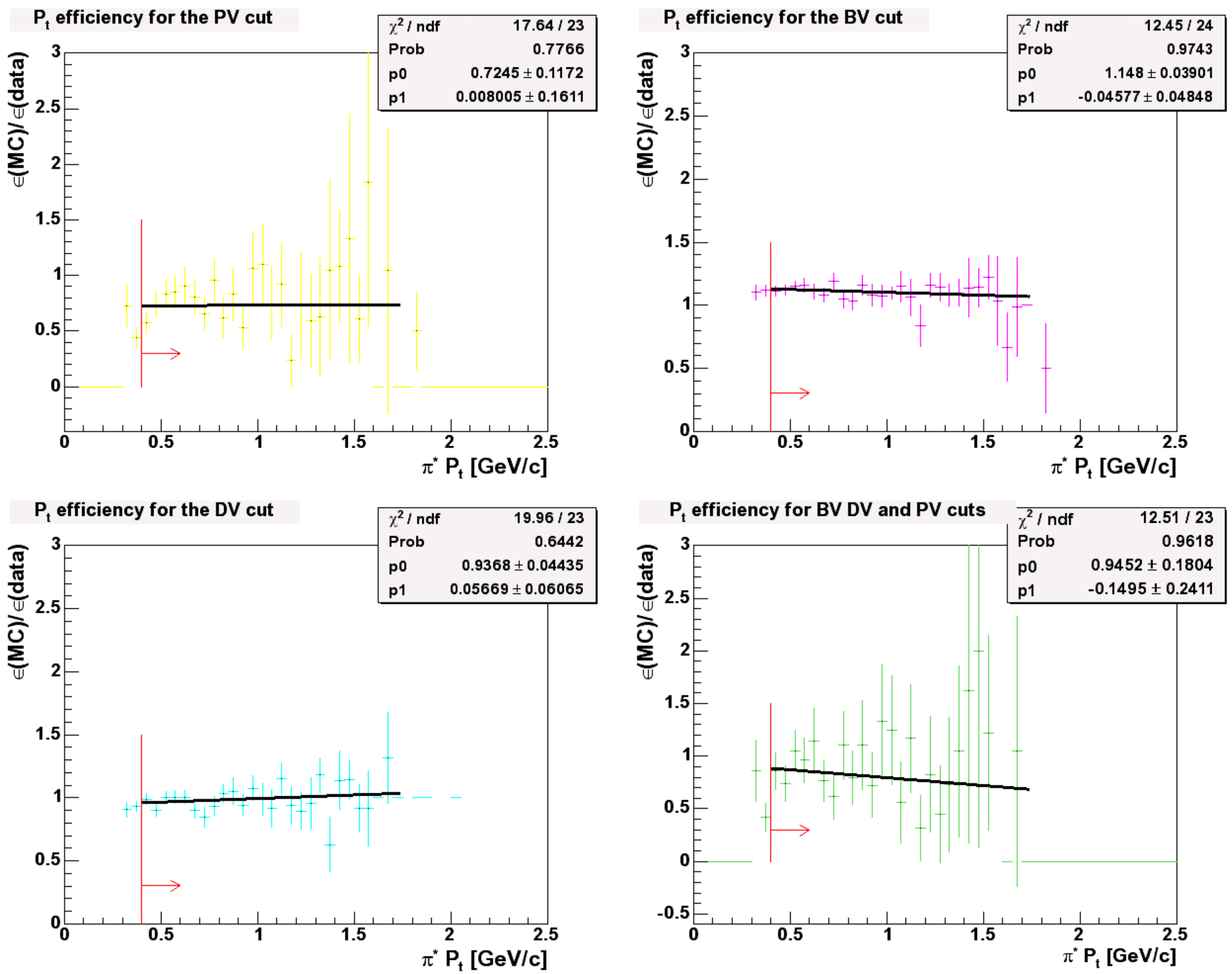


Another perspective:

MC(after/before) / data(after/before)

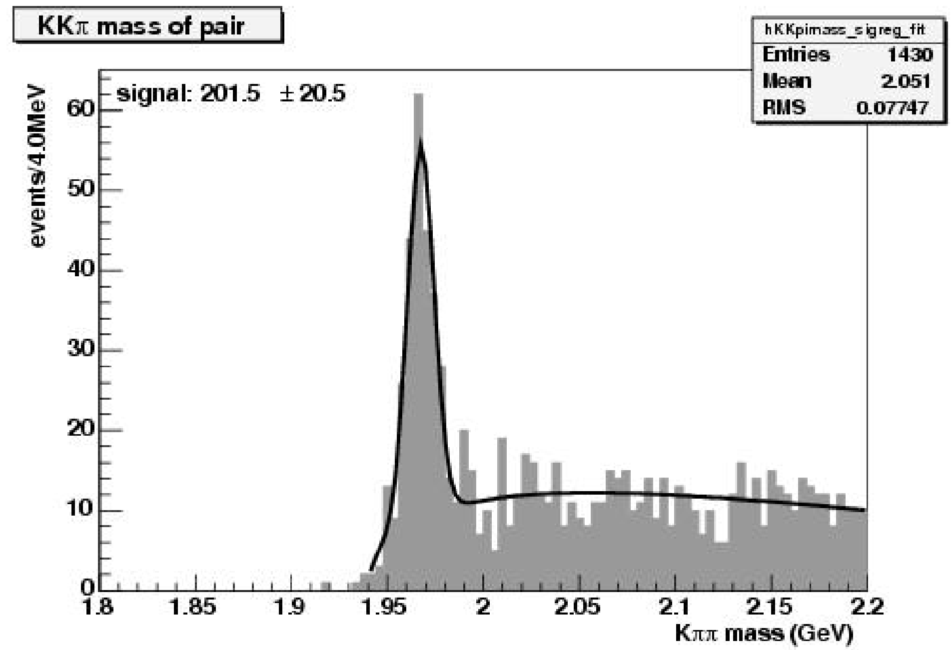


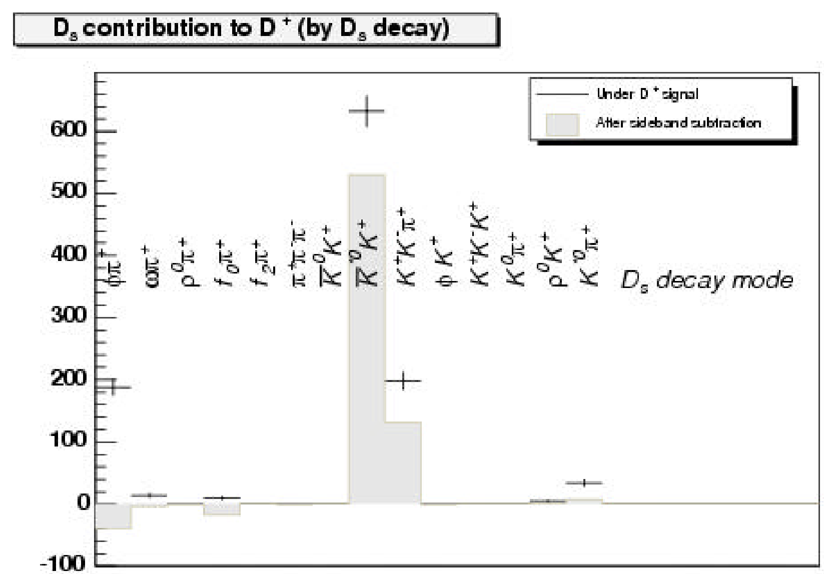
MC(after/before) / data(after/before)
Plan for the evaluation of systematics



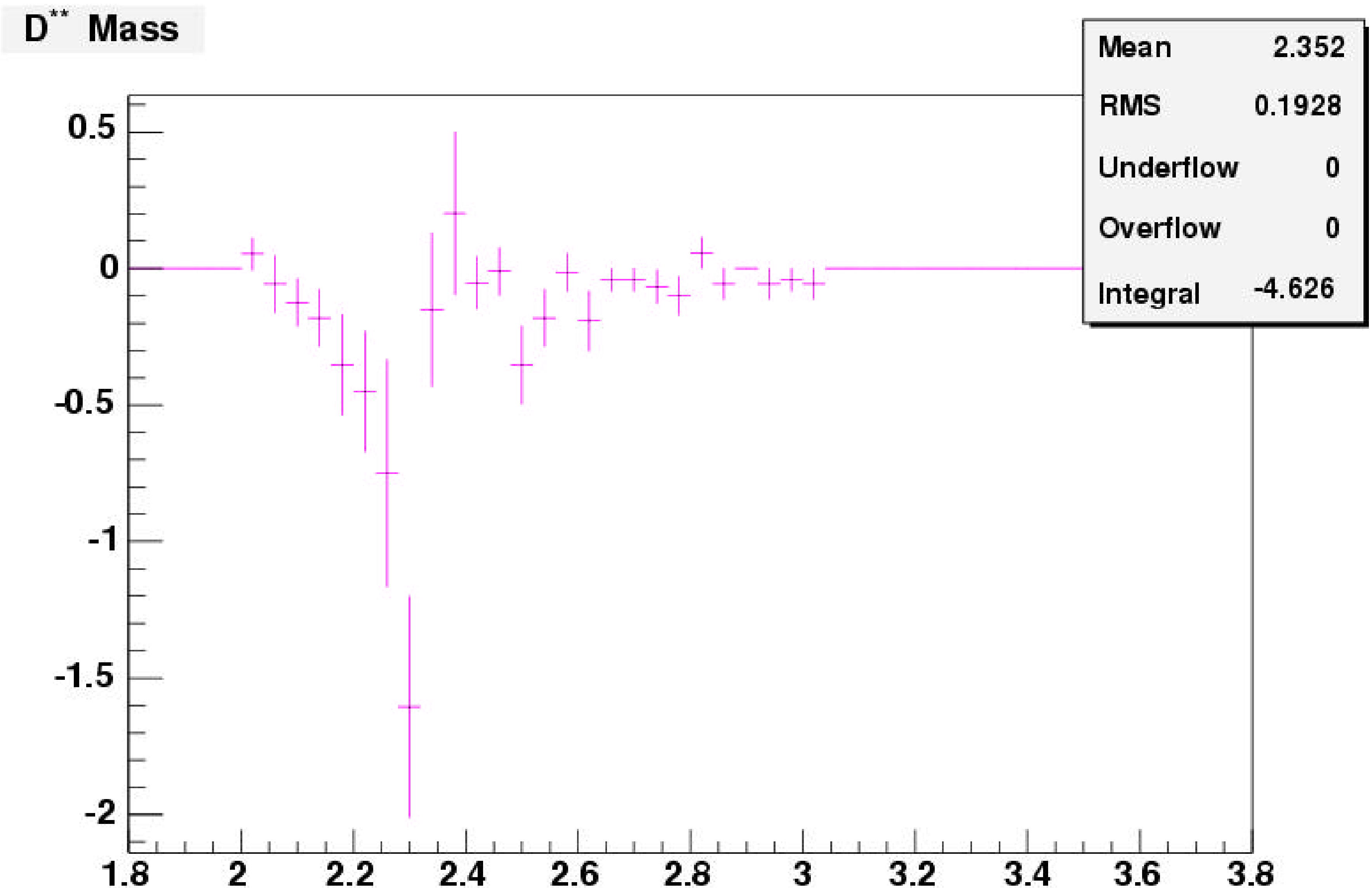
D_s Background

- Use ϕ peak in D+ candidates to set the scale
- Measure the relative contribution of D_s decays to D^+ fakes using MC
- Extrapolate to the total size of the contribution: 4%
- Build a suitable D** background model
- Subtract



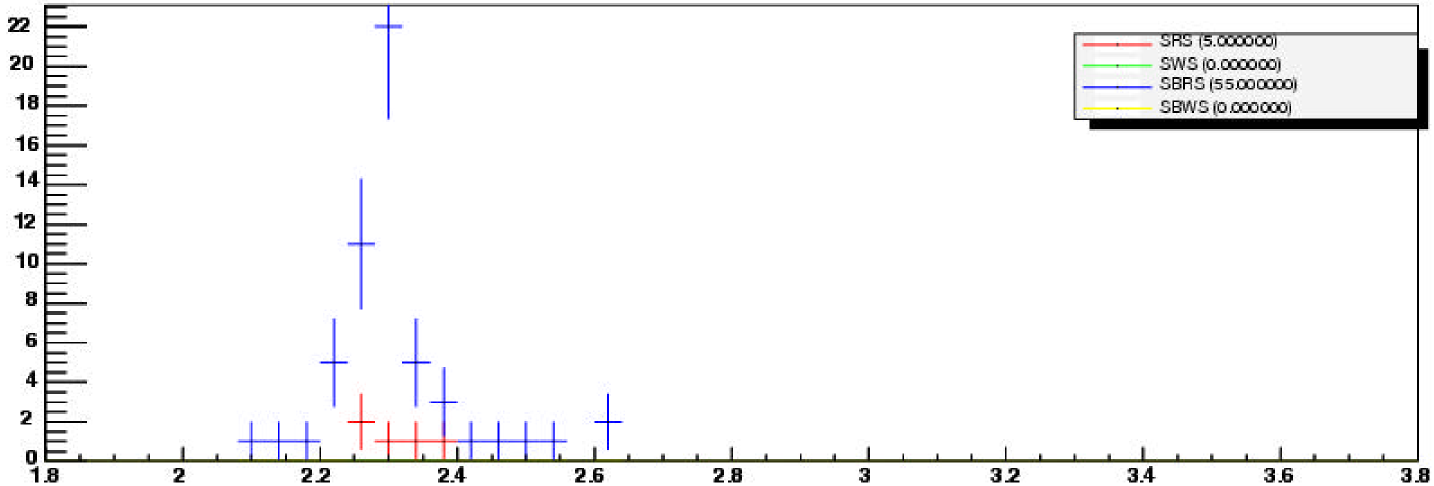


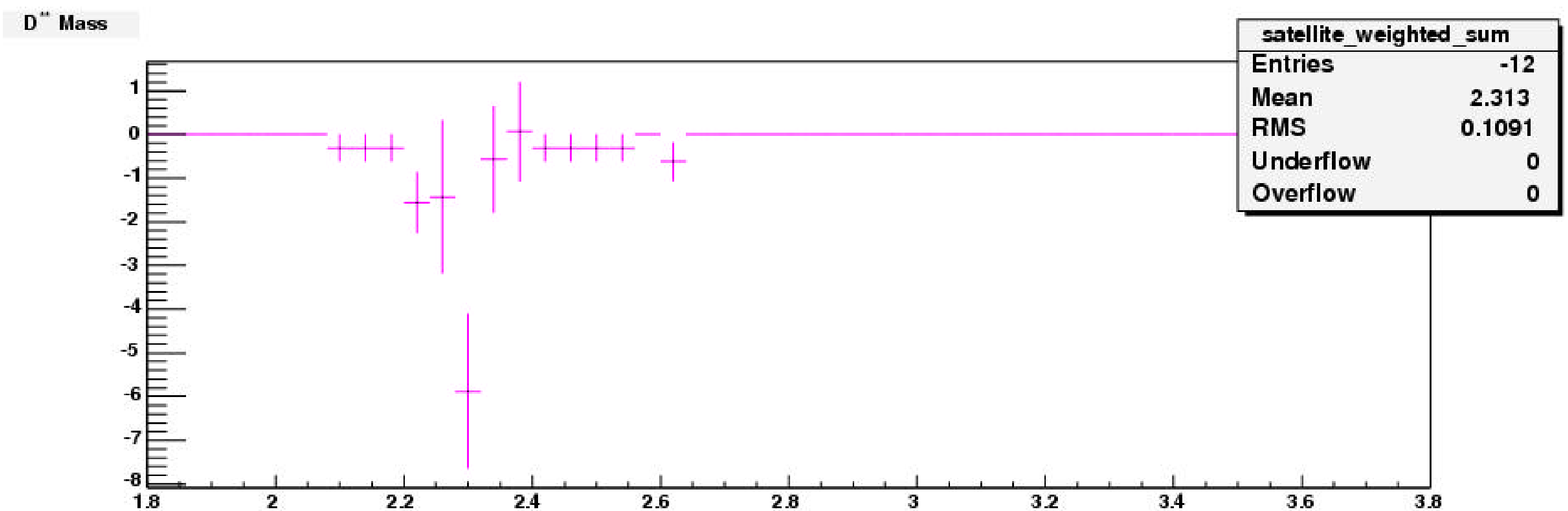
Cross-feeds



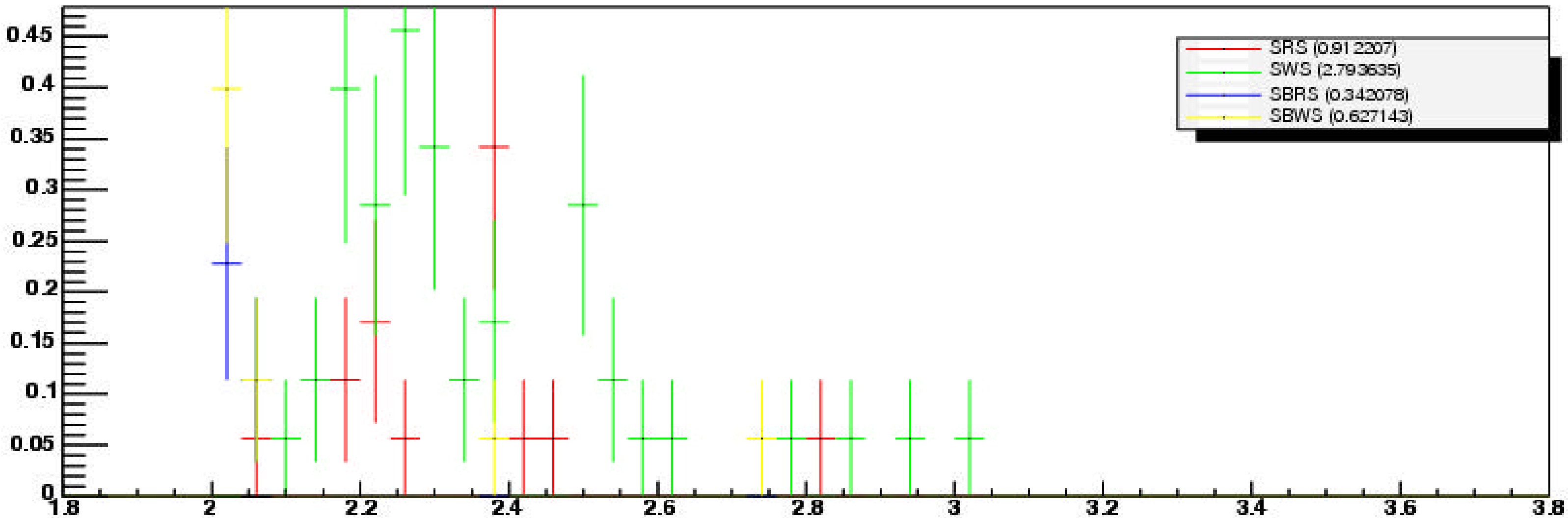
D** Mass
Mean 2.352
RMS 0.1928
Underflow 0
Overflow 0
Integral -4.626
0.5
0
-0.5
-1
-1.5
-2
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8

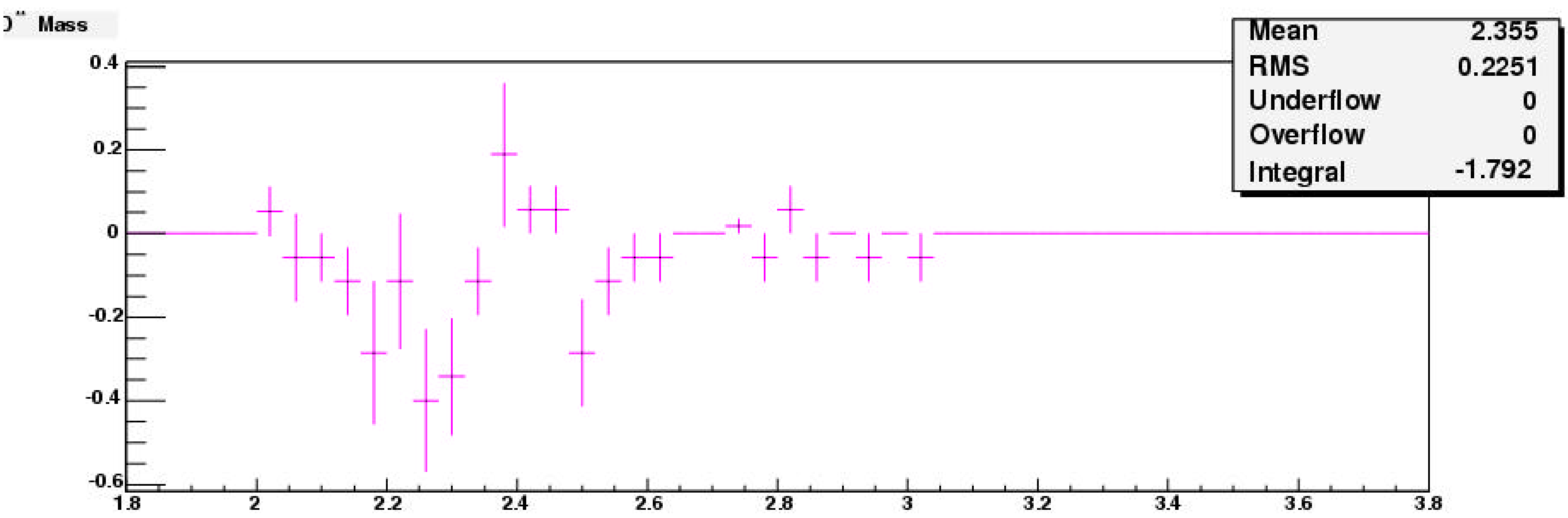
Cross-feeds (details, sat.)



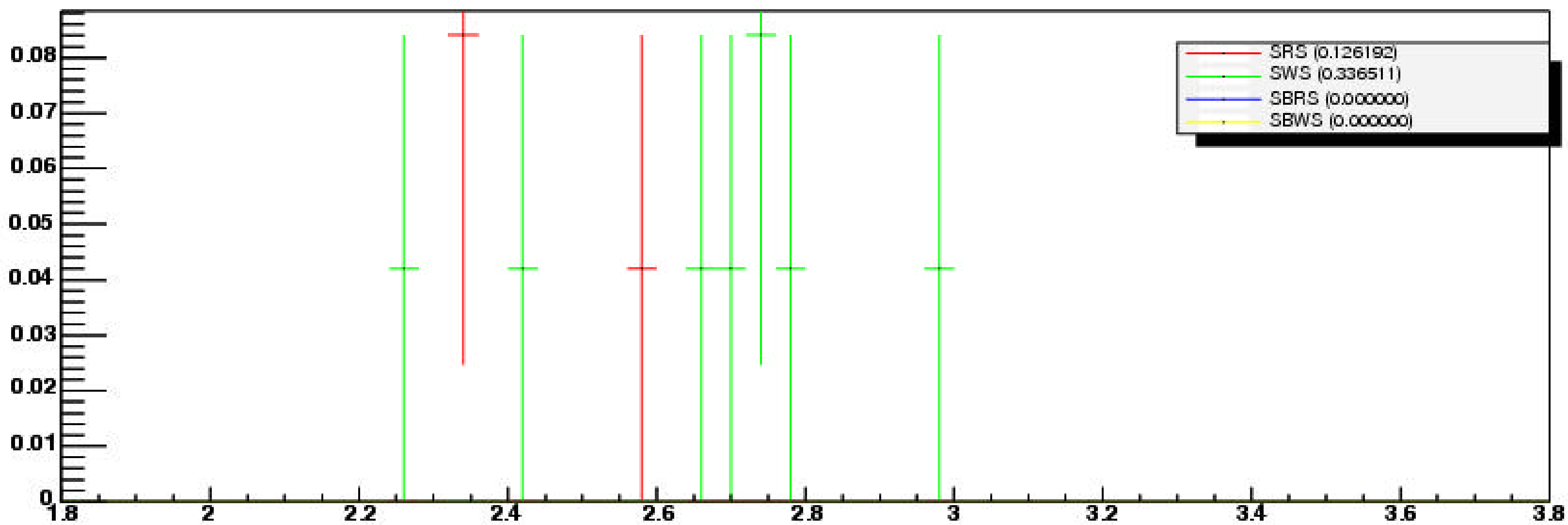


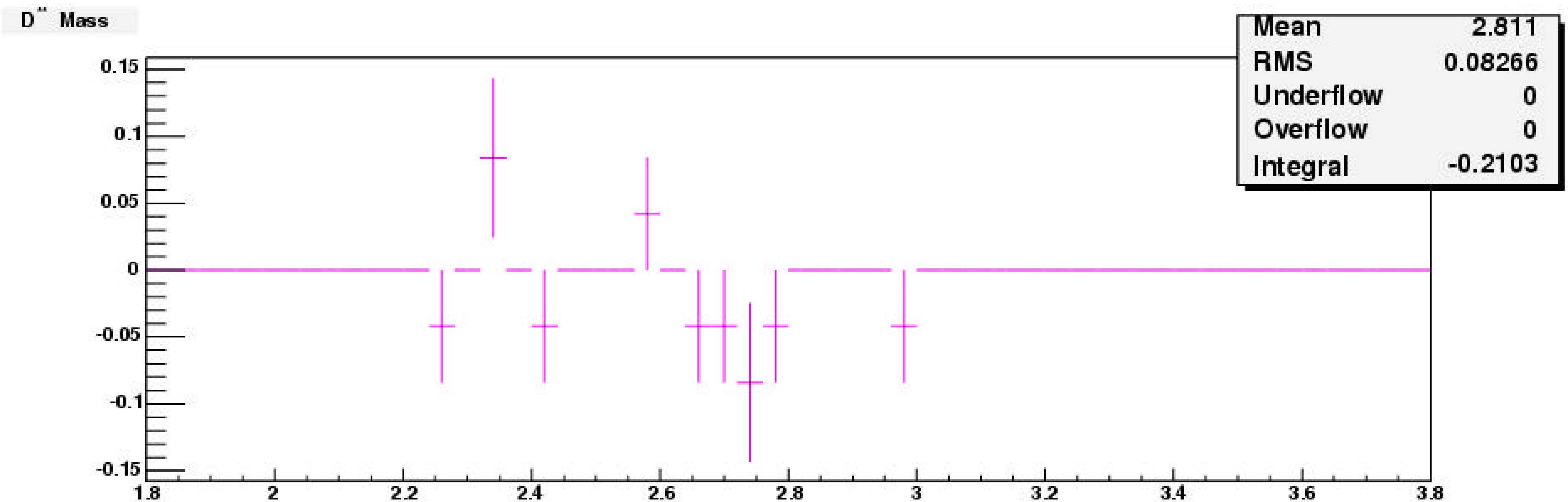
Cross-feeds (details, $K\pi\pi\pi$)





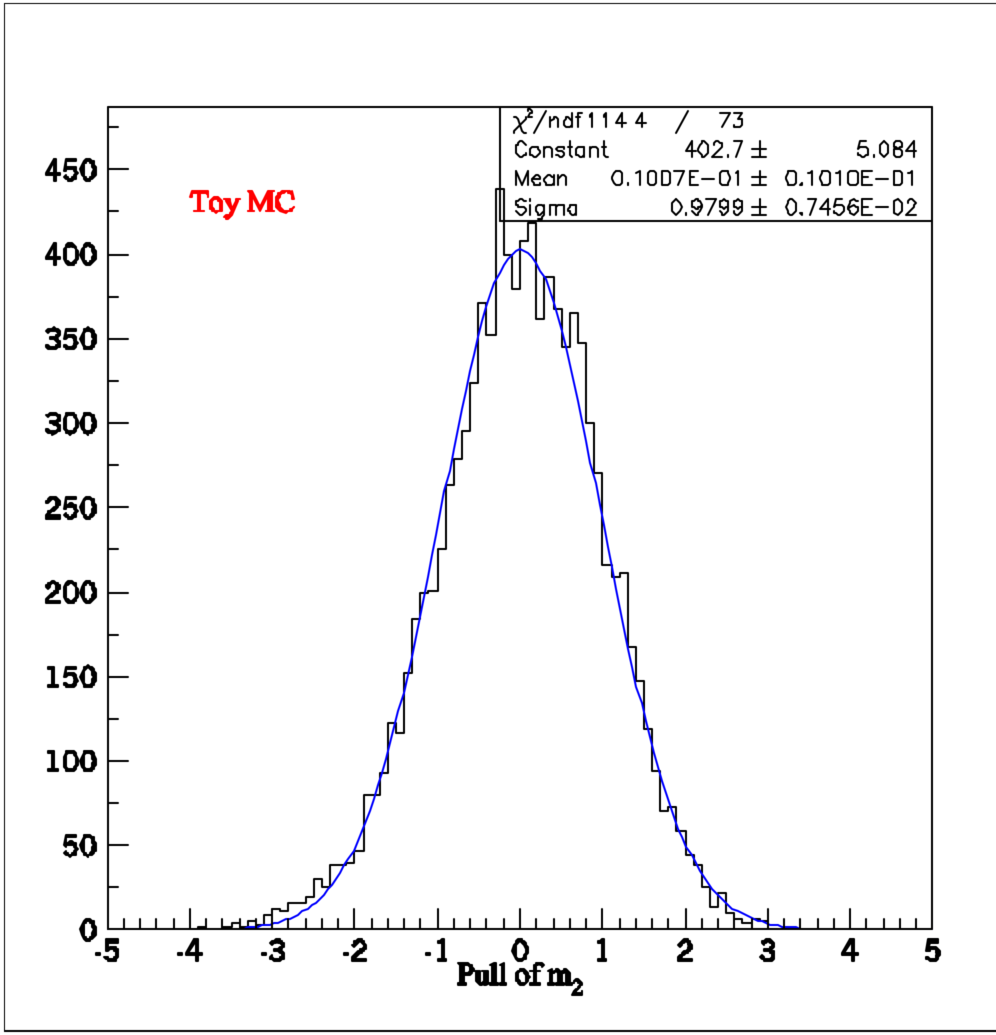
Cross-feeds (details Kπ)





D** Moments

- Combine all events of all types in all channels (D^*, D^+, SRS, SBRS, feed-down, etc.)
- Compute mean (m_1) and variance (m_2) of M^2 distribution with weighted events.
- Errors and correlation computed with MC (for toy MC) or bootstrap (for data).
- For some realizations, one finds a negative value for $m_2 = Var(M^2) = \langle M^4 \rangle - \langle M^2 \rangle^2$.



Inputs for the D^0 and D^{*0} Contributions

- For the BR's, results from charged and neutral B decays are combined using isospin: partial widths are assumed equal.
- BR's, ratio of lifetimes and ratio of production fractions are taken from PDG.
- Toy Monte Carlo is used to propagate the uncertainties from m_1, m_2, the BR's, etc., to uncertainties on M_1 and M_2 and their correlation.

Directory name	Summary			Decay Table	Gen	Sim(s)	Prod	PHOTOS
PDSF://auto/cdf2/hcfang								
Direct decay of B into D and D*								
DplusK2Pi_MC_4.9.1pms/	B->eD^{+}v		D^{+}->K2pi	bdtoedpl_dplink2pi_hcfang	4.9.1pms	4.9.1pms	4.9.1pms	y
DplusK2Pi_MC_4.9.1pms_4.10.0/	B->eD^{+}v		D^{+}->K2pi	same as above	4.10.0	4.10.0	4.9.1pms	y
DstarK3Pi_MC_4.9.1pms/	B->eD*v		D^{0}->K3pi	bdtoedst_dzink3pi_hcfang	4.9.1pms	4.9.1pms	4.9.1pms	y
muDstarK1Pi_MC_4.9.1pms_4.10.0/	B->muD*v		D^{0}->Kpi	bdtomudst_dzinkpi_hcfang	4.10.0	4.10.0	4.9.1pms	y
bdtoedst_dstind0pi_d0ink3pi_4.10.0_prod4.9.1hpt1/	B->eD*v		D^{0}->K3pi	bdtoedst_dstind0pi_d0ink3pi_hcfang	4.10.0	4.10.0	4.9.1hpt1	y
bdtoedst_dstind0pi_d0inkpipi0_4.10.0_prod4.9.1hpt/	B->eD*v		D^{0}->Kpipi0	bdtoedst_dstind0pi_d0inkpipi0_hcfang	4.10.0	4.10.0	4.9.1hpt1	y
D** MC files								
Dstarstar_GenLvlMC_4.10.0/	B->eD**v	D**->D*		bptodss	4.10.0	--	--	y
Dstarstar_MC_files_4.9.1pms/	B->eD**v	D**->D*		same as above	4.9.1pms	4.9.1pms	4.9.1pms	y
Dstarstar_MC_files_4.9.1pms_part2/	(continuation of above)			same as above				
bptoedss_noPHOTOS_GenLvl_4.10.0/	B->eD**v	D**->D*		bptoedss_noPHOTOS	4.10.0	--	--	n
bptomudss_noPHOTOS_GenLvl_4.10.0/	B->muD**v	D**->D*		bptomudss_noPHOTOS	4.10.0	--	--	n
dsstodpl_dplink2pi_GenLvl_4.10.0/	B->eD**v	D**->D^{+}	D^{+}->K2pi	bptodss_dsstodplpi_dpltok2pi	4.10.0	--	--	y
dsstodpl_dplink2pi_4.10.0_4.9.1pmsProd/	B->eD**v	D**->D^{+}	D^{+}->K2pi	same as above	4.10.0	4.10.0	4.9.1pms	y
PDSF://auto/pdsfdv47/cdf/hcfang/								
Direct decay of B into D and D*								
Dstar_MC_files_4.9.1pms_try2/	B->eD*v		D^{0}->Kpi	bdtoedst_dzinkpi_hcfang	4.9.1pms	4.9.1pms	4.9.1pms	y
bdtoedst_dstindplpi0/	B->eD*v	D*->D+pi0	D+->K2pi	bdtoedst_dstindplpi0	4.10.0	4.10.0	4.9.1pms	y
D** MC files								
bptoedssCont_noPHOTOS_GenLvl/	B->eD**(non-res)v	D**->D*pi		bptoedssCont_noPHOTOS	4.10.0	--	--	n
bptoedssCont_noPHOTOS/	B->eD**(non-res)v	D**->D*pi		same as above	4.10.0	4.10.0	4.9.1pms	n
bptoedssContDpl_noPHOTOS_GenLvl	B->eD**(non-res)v	D**->D+pi		bptoedssContDpl_noPHOTOS	4.10.0	--	--	n
bptoedssContDpl_noPHOTOS	B->eD**(non-res)v	D**->D+pi		same as above	4.10.0	4.10.0	4.9.1pms	n
PDSF://auto/pdsfdv50/cdf/hcfang/								
D** MC files								
B0SemiLeptonic/	B->muD**v	all final states with		bdto_decayB0SemiLeptonic	4.10.0	4.10.0	4.9.1pms	y
BPlusSemiLeptonic/	B->muD**v	Kpi, K2pi, K3pi		bpto_decayBPlusSemiLeptonic	4.10.0	4.10.0	4.9.1pms	y
Hadronic B decays								
bdtodstarpi_d0tokpi/	B->D*pi+	D*->D^{0}pi	D^{0}->Kpi	bdtodstarpi_d0tokpi	4.10.0	4.10.0	4.9.1pms	n