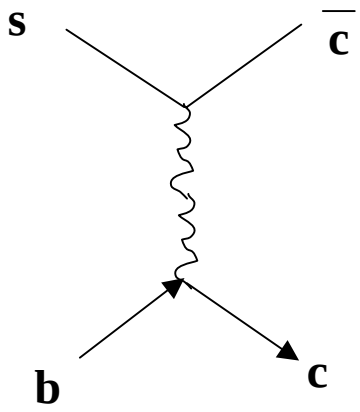
Inklusive b-Zerfälle in „wrong sign“ Charm Mesonen

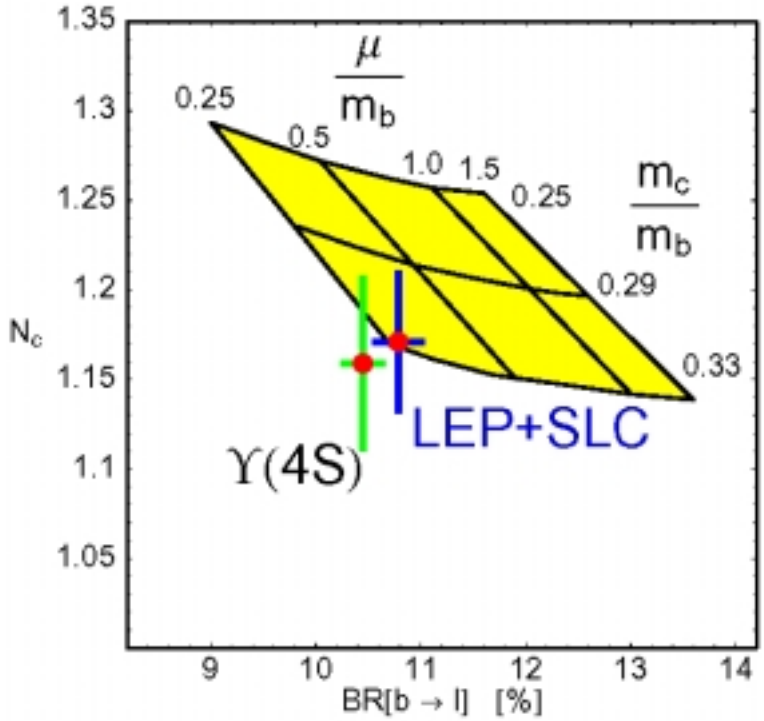
Ch. Schwanda: Dissertation und Publikation



$n_C = 1 + Br(b \rightarrow c\bar{c}s)$

HQET

n_c



Br(B → semileptonisch)

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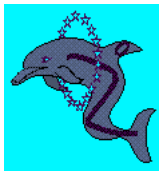
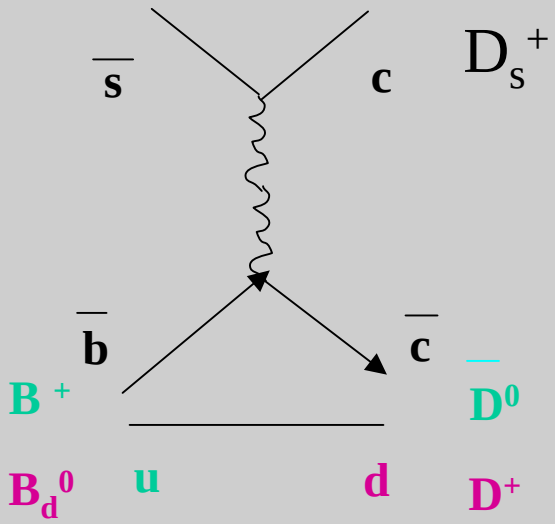


Exklusive Rekonstruktion von Charm Mesonen $D_{(s)}$ als b-Tagging

1. Schritt : DELPHI b-Tag + Rekonstruktion $B \rightarrow \overline{D} D_S$



$D_{(s)}$:

$D^+ \rightarrow K^- \pi^+ \pi^+$

$D^0 \rightarrow K^- \pi^+$

$D_s^+ \rightarrow \Phi \pi^+$

$\Downarrow$

$K^- K^+$

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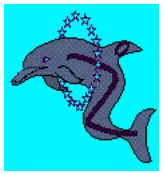
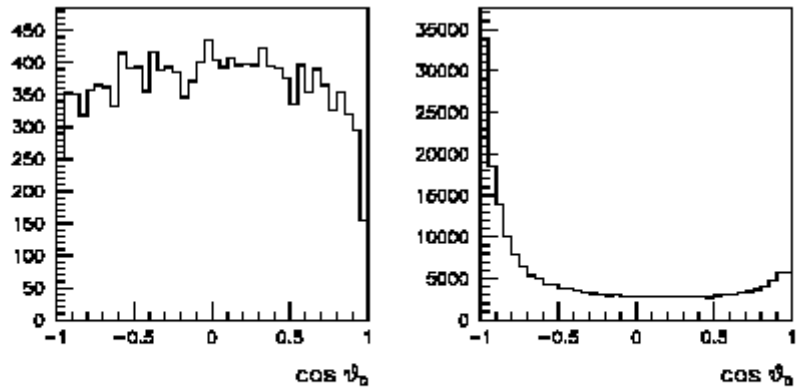


Untergrundunterdrückung durch Diskriminanten

$D^0 \rightarrow K^- \pi^+$

Signal **Untergrund**



(a) (b)

Figure 5.7: The distribution of the cosine of the decay angle θ_D for $D^0 \rightarrow K^-\pi^+$ candidates: (a) signal, (b) combinatorial background.

Θ_D

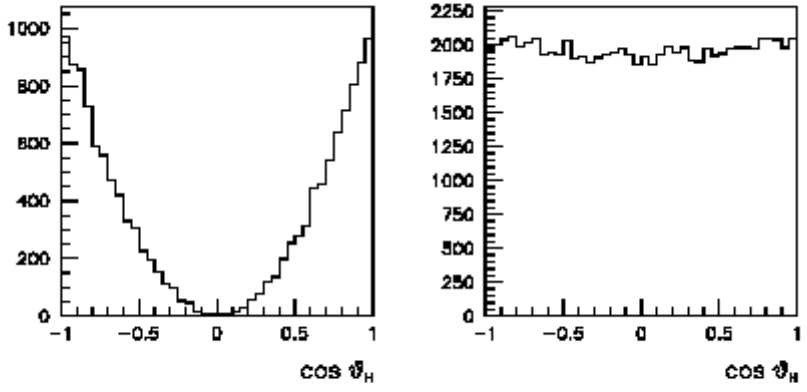
flach in $\cos\Theta_D$

D^0 –Ruhsystem

K, D^0(Lab)

$D_s^+ \rightarrow \Phi\, \pi^+$

Signal **Untergrund**



(a) (b)

Figure 5.8: The cosine of the helicity angle θ_H for $D_s^+ \rightarrow \phi\pi^+$ candidates: (a) signal, (b) combinatorial background.

$|Y_{1,0}|^2 \propto \cos^2\Theta_H$

K^+, D_s

Φ–Ruhsystem Helizität

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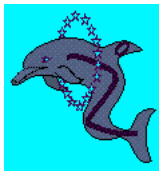


Kombination aller Variablen x_i für $D^0 \to K^- \pi^+$

$$R(D_{(s)}) = \prod_{i=1}^{n} \frac{S_i(x_i; D_{(s)})}{B_i(x_i; D_{(s)})} \ ,$$

$$Y(D_{(s)}) = \frac{R(D_{(s)})}{1 + R(D_{(s)})} \ .$$

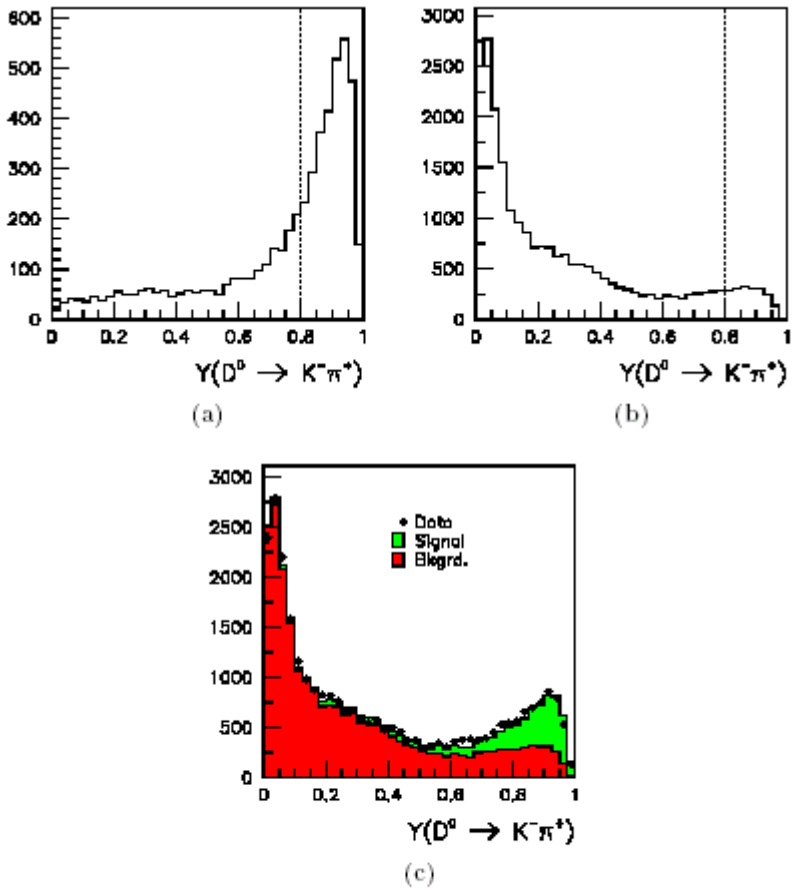
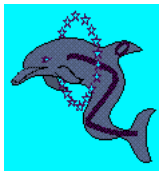


Figure 5.9: The combined discriminant variable for $D^0 \to K^-\pi^+$ candidates: (a) signal, (b) combinatorial background. (c) Comparison between real data and simulation. The cut $Y(D^0 \to K^-\pi^+) > 0.8$ is shown by the dotted vertical line.



Kombination aller Variablen x_i für $D^+ \to K^- \pi^+ \pi^+$

$$R(D_{(s)}) = \prod_{i=1}^{n} \frac{S_i(x_i; D_{(s)})}{B_i(x_i; D_{(s)})} \ ,$$

$$Y(D_{(s)}) = \frac{R(D_{(s)})}{1 + R(D_{(s)})} \ .$$

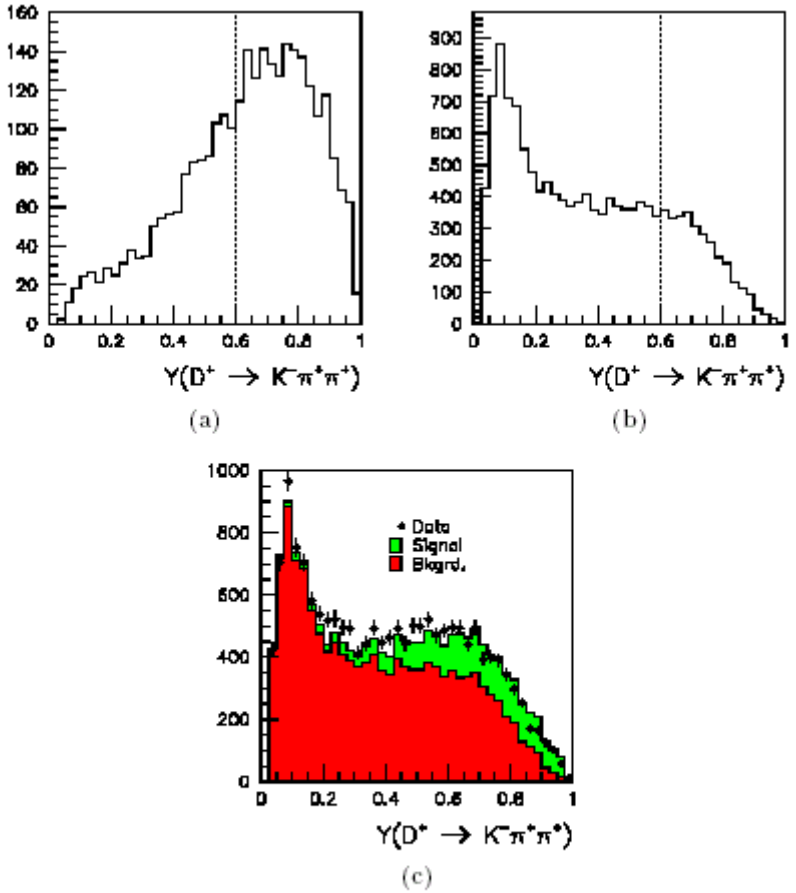
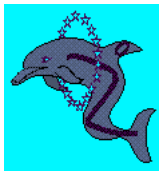


Figure 5.10: The combined discriminant variable for $D^+ \to K^-\pi^+\pi^+$ candidates: (a) signal, (b) combinatorial background. (c) Comparison between real data and simulation. The cut $Y(D^+ \to K^-\pi^+\pi^+) > 0.6$ is shown by the dotted vertical line.



Kombination aller Variablen x_i für $D_s^+ \to \Phi \pi^+$

$$R(D_{(s)}) = \prod_{i=1}^{n} \frac{S_i(x_i; D_{(s)})}{B_i(x_i; D_{(s)})} \ ,$$

$$Y(D_{(s)}) = \frac{R(D_{(s)})}{1 + R(D_{(s)})} \ .$$

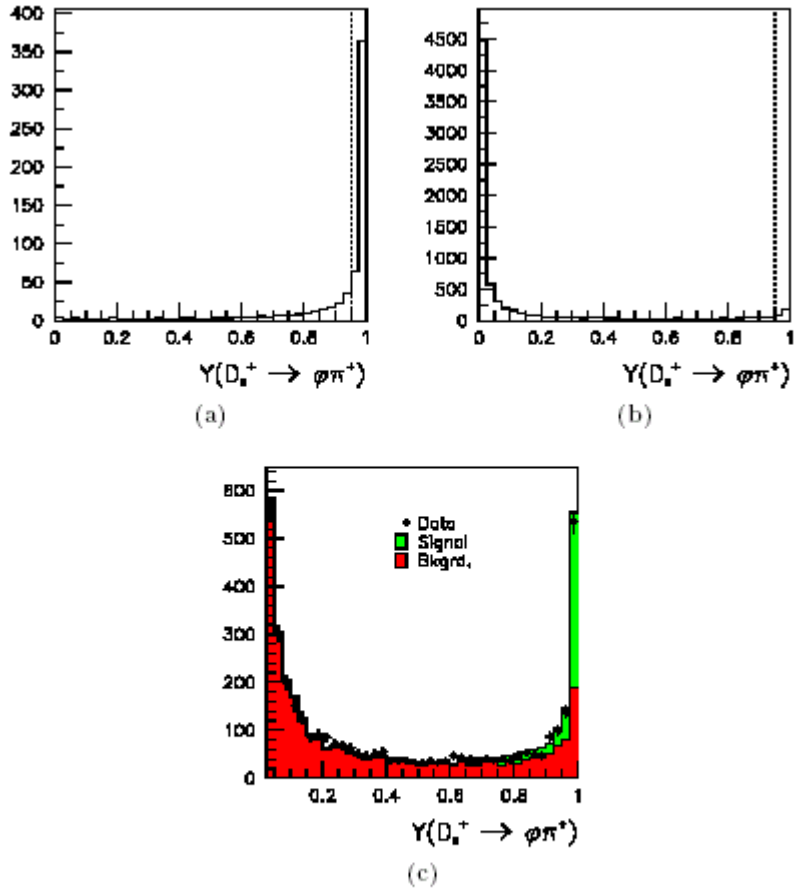
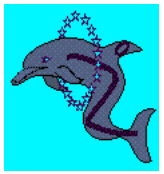
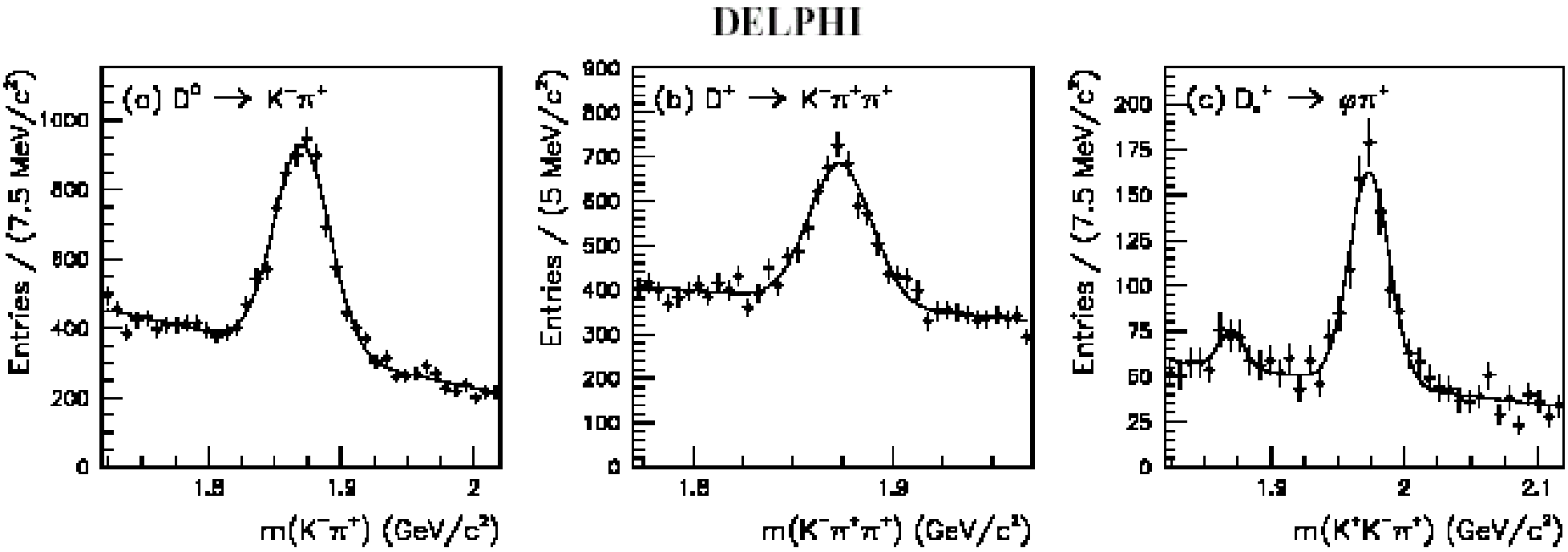
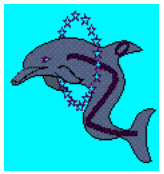


Figure 5.11: The combined discriminant variable for $D_s^+ \to \phi\pi^+ \to K^+K^-\pi^+$ candidates: (a) signal, (b) combinatorial background. (c) Comparison between real data and simulation. The cut $Y(D_s^+ \to \phi\pi^+) > 0.95$ is shown by the dotted vertical line.



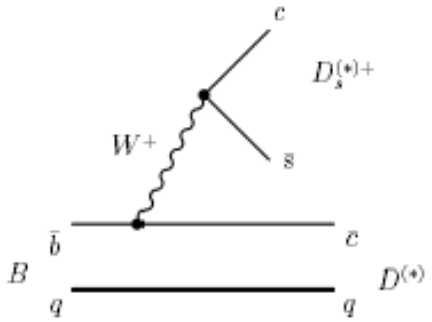
$D_{(s)}$:


DELPHI
(a) $D^0 \to K^-\pi^+$
Entries / (7.5 MeV/c²)
m(K⁻π⁺) (GeV/c²)
(b) $D^+ \to K^-\pi^+\pi^+$
Entries / (5 MeV/c²)
m(K⁻π⁺π⁺) (GeV/c²)
(c) $D_s^+ \to \phi\pi^+$
Entries / (7.5 MeV/c²)
m(K⁺K⁻π⁺) (GeV/c²)

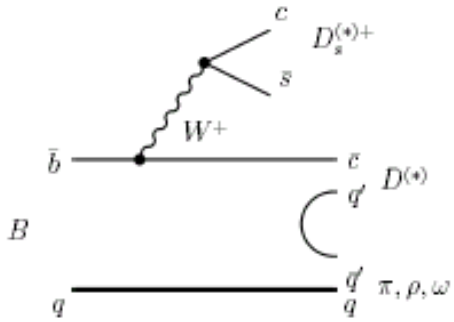


Inklusive Messung „wrong sign“

$B \to D_s^{(*)} \bar{D}^{(*)}$



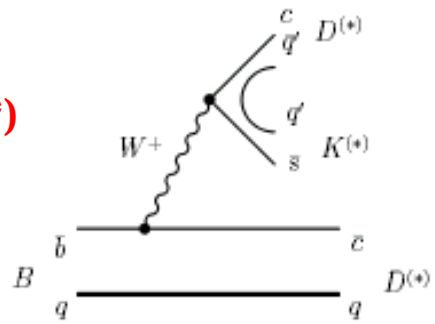
(a)



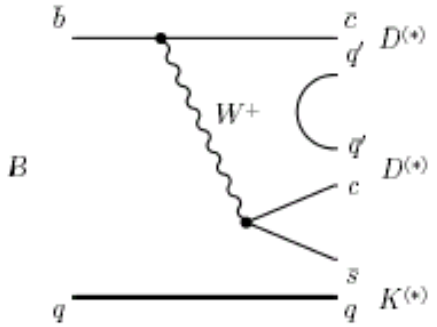
(b)

$B \to D_s^{(*)} \bar{D}^{(*)} \pi$
ρ, ω

$B \to D^{(*)} \bar{D}^{(*)} K^{(*)}$

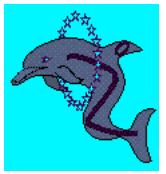


(c)



(d)

$B \to D^{(*)} \bar{D}^{(*)} K^{(*)}$



Separation von Fragmentation und B-Zerfall mit Rapidität

$$y = \frac{1}{2} 1n \frac{E + p_L}{E - p_L}$$

für y >1.6

$$p_b = \sum_{y_i > 1.6} p_i$$

4-Impuls für b quark

$\cos\Theta_D$ flach für Zerfall

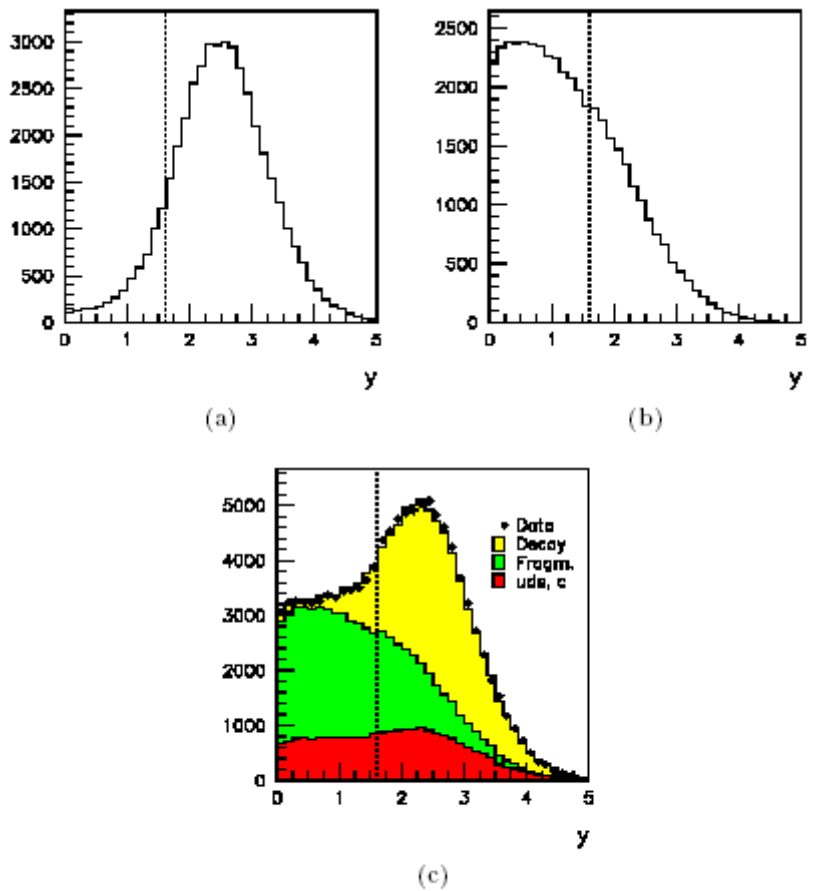
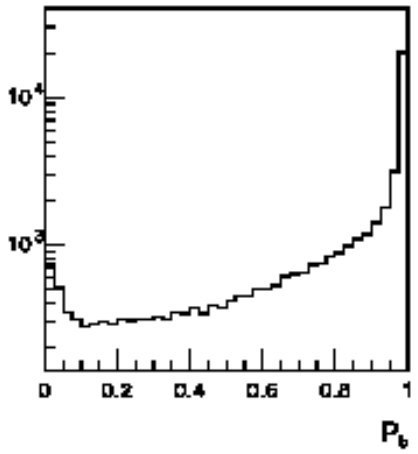


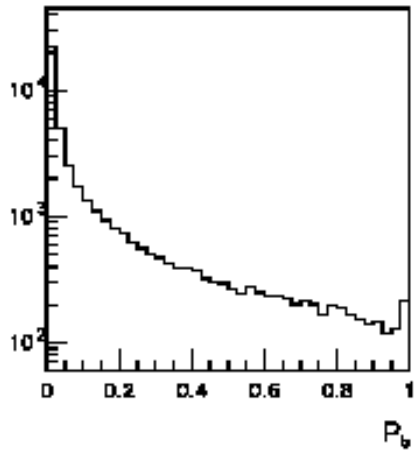
Figure 6.2: The rapidity of charged tracks: (a) b decay tracks, (b) fragmentation tracks. (c) Comparison between real data and simulation. The dotted vertical line shows the cut $y > 1.6$.

b-Spur Netzwerk für geladene Spuren

Zerfall



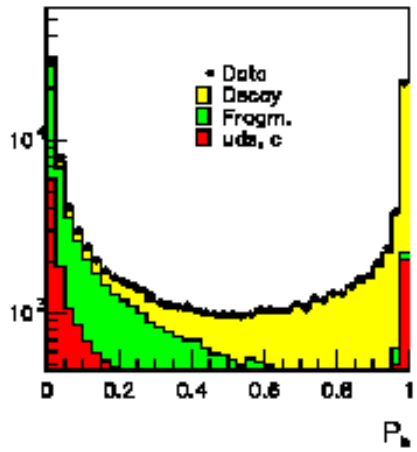
(a)



(b)

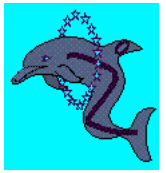
Fragmentation

TrackNet

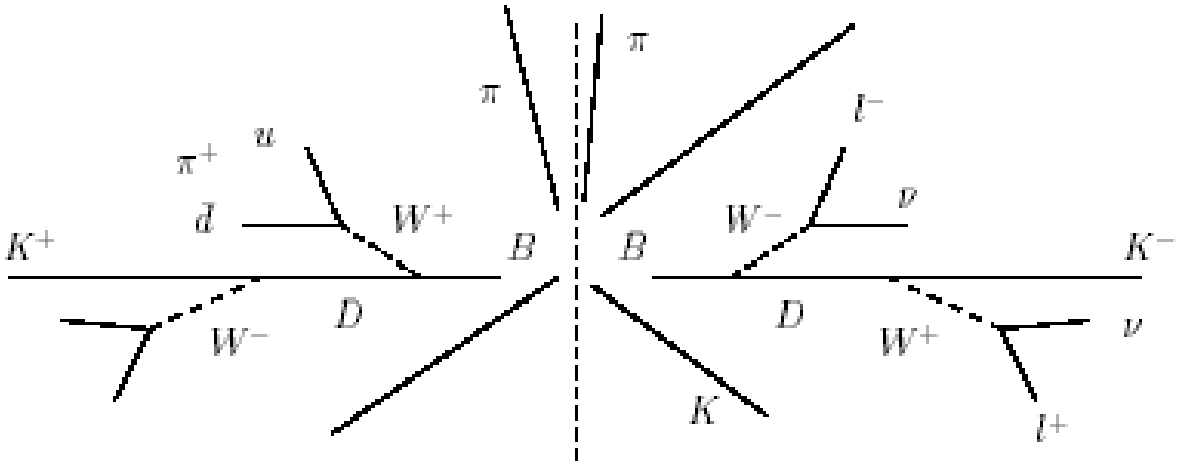


(c)

Figure 6.6: The b track probability network for charged tracks: (a) b decay tracks, (b) fragmentation tracks. (c) Comparison between the real data and simulation.



BSAURUS – Neuronales Netz bei DELPHI



Verwendet alle Info: $D_{(s)}$ exklusiv bekannt

Teilchenidentifikation, B und D Vertexseparation, Spur- und Hemisphärenqualität

Verschiedene neuronale Netze für B^+, B^0, B_s^0, Λ_b

Ladungskorrelation zwischen b-Ladung bei Produktion und Fragmentationsladung

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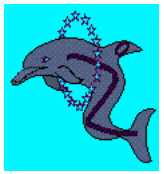
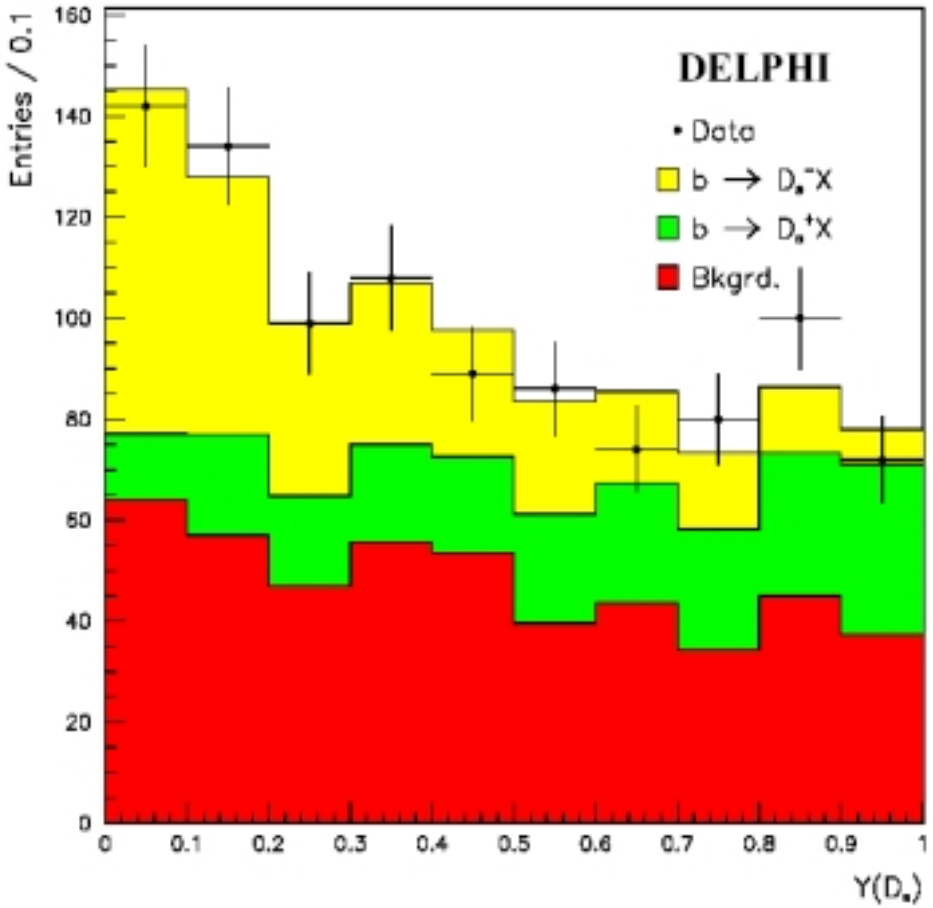
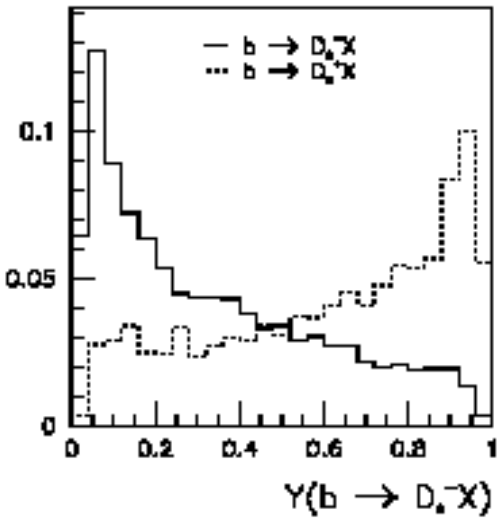
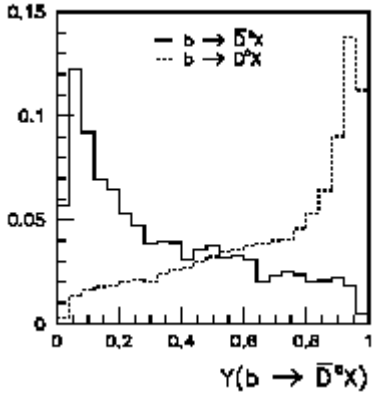


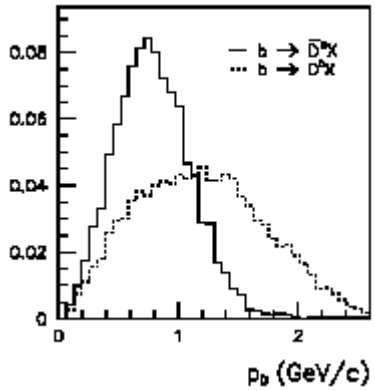
„Wrong sign“ Tag als einziger Ausgangsparameter

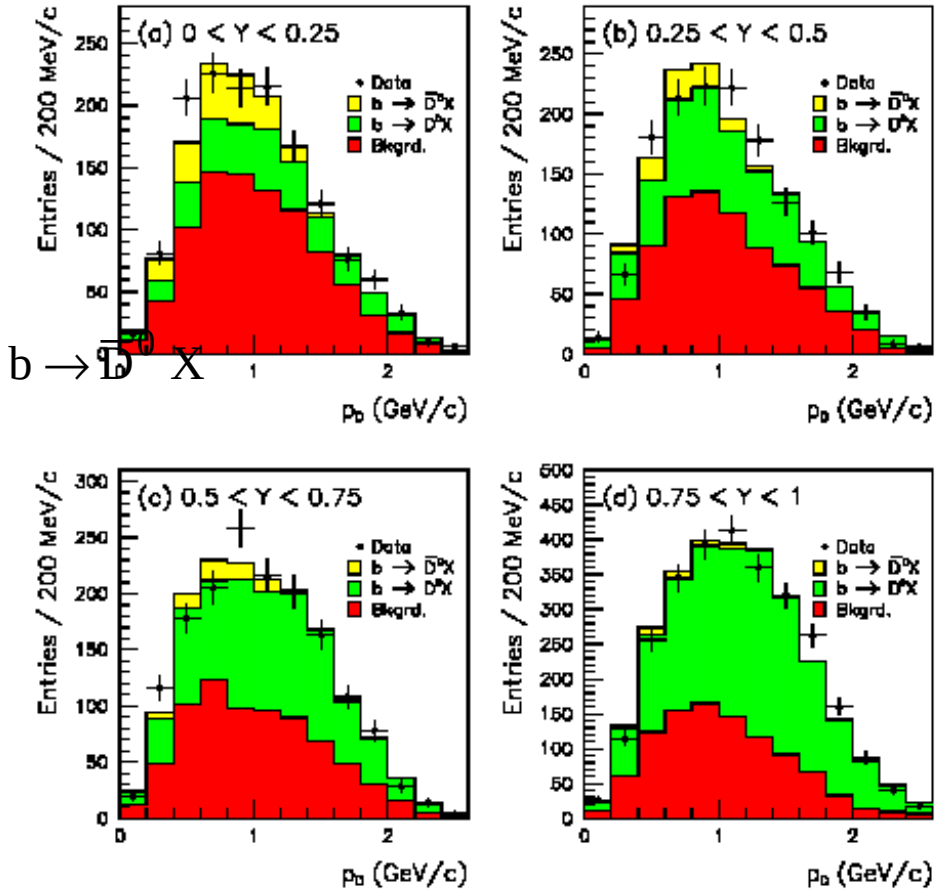




Für $b \to \overline{D}^0 X$ zusätzliche Diskriminante durch D-Impuls im b-Ruhsystem

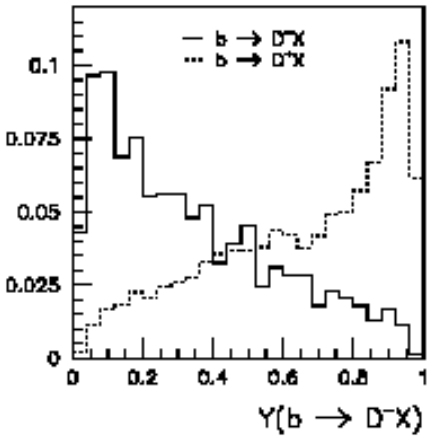


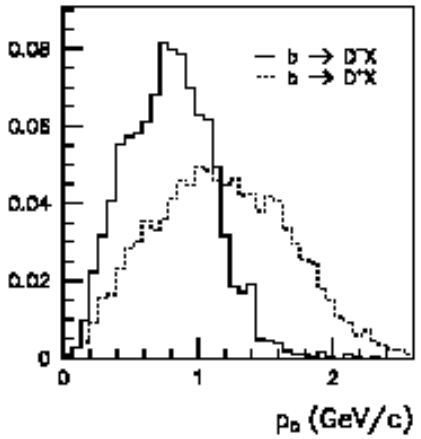


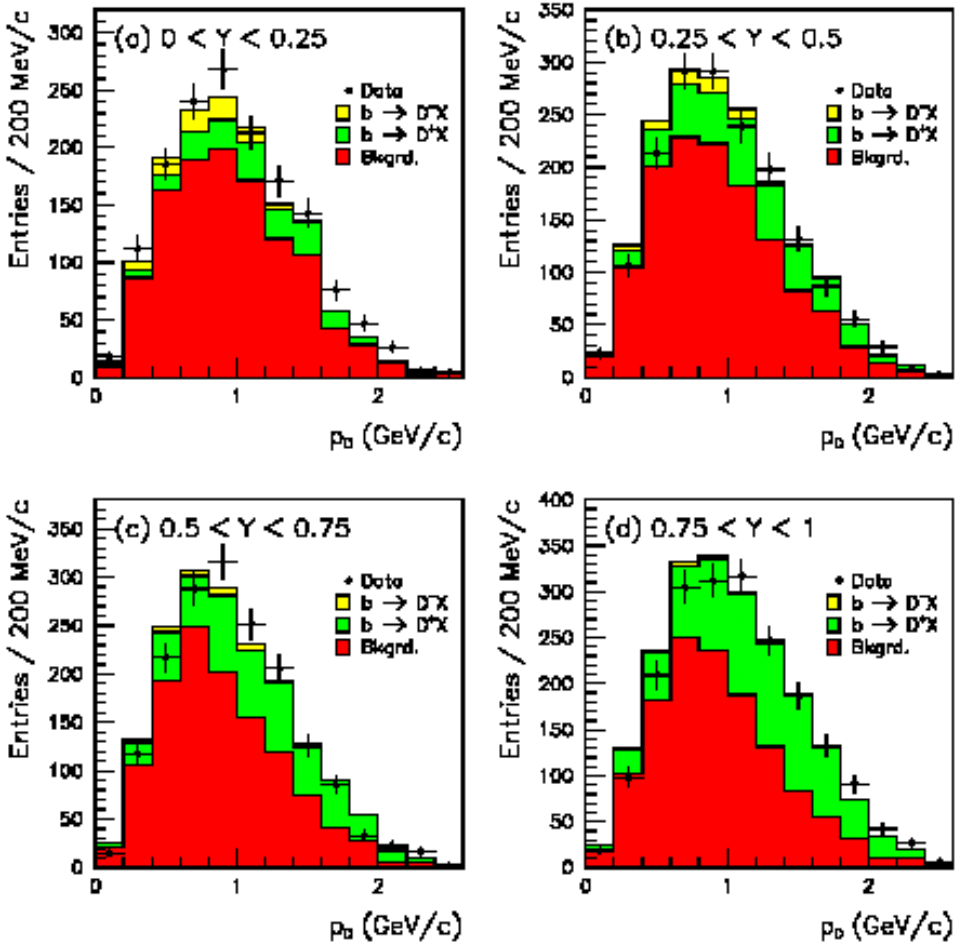


$b \to \overline{D}^0 X$

Für $b \rightarrow D^- X$ zusätzliche Diskriminante durch D-Impuls im b-Ruhsystem







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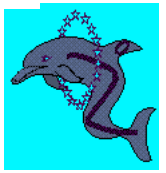


Fit-Prozedur

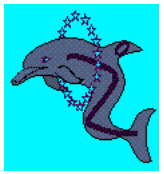
Für $D_s^+ \to \Phi\,\pi^+$

$$N_i = N_W\,F_i^W + N_R\,F_i^R + N_{c\bar{c}}\,F_i^{c\bar{c}} + N_{Bkgrd}\,F_i^{Bkgrd}$$

Für $D^+ \to K^-\pi^+\pi^+$ und $D^0 \to K^-\pi^+$

$$N_{ij} = N_W\,F_{ij}^W + N_R\,F_{ij}^R + N_{c\bar{c}}\,F_{ij}^{c\bar{c}} + N_{Bkgrd}\,F_{ij}^{Bkgrd}$$

Sample	Wrong sign evts.	Right sign evts.	χ^2/ndf	$\varepsilon_W/\varepsilon_R$	$\frac{B(b \to \bar{D}_{(s)}X)}{B(b \to D_{(s)}, \bar{D}_{(s)}X)}$ %
$D^0 \to K^-\pi^+$	383 ± 81	3,396 ± 110	52.0/(52−1)	0.92 ± 0.02	11.0±2.1±1.5
$D^+ \to K^-\pi^+\pi^+$	186 ± 86	1,811 ± 101	62.3/(52−1)	0.80 ± 0.03	11.4±4.7±3.2
$D_S^+ \to \phi\,\pi^+$	286 ± 42	221 ± 39	7.4/(10−1)	1.01 ± 0.03	56.2±5.7±3.3

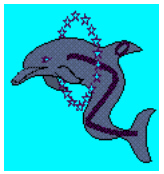


Systematische Fehler

$$\frac{\mathrm{Br}(b \to \overline{D}_{(s)} X)}{\mathrm{Br}(b \to D_{(s)}, \overline{D}_{(s)} X)} = \frac{N_W}{N_W + (\varepsilon_W / \varepsilon_R) N_R}$$

Source	Value	$\Delta\mathcal{B}(b \to \bar{D}^0 X)$ (%)	$\Delta\mathcal{B}(b \to D^- X)$ (%)	$\Delta\mathcal{B}(b \to D_s^- X)$ (%)	Ref.
Model dependence (w.s.)					
$B \to D_s^{**} \bar{D}$ fraction	$(50 \pm 25)\%$	0.07	0.27		[23, 24]
$B \to D_s^{(*)+} \bar{D}^{(*)}$ fraction	$(50 \pm 13)\%$			0.10	[21, 22]
Model dependence (r.s.)					
$\mathcal{B}(b \to D^0 l^- \bar{\nu} X)$	$(6.6 \pm 0.6)\%$	0.12			[27]
$\mathcal{B}(b \to D^+ l^- \bar{\nu} X)$	$(2.02 \pm 0.29)\%$		0.14		[27]
$\mathcal{B}(b \to D_s^+ l^- \bar{\nu} X)$	$(0.87 \pm 0.28)\%$			0.11	[1]
$\mathcal{B}(b \to D^0 D_s^- X)$	$(9.1 \pm 3.35)\%$	0.05			[23]
$\mathcal{B}(b \to D^+ D_s^- X)$	$(4.0 \pm 2.05)\%$		0.14		[23]
$\mathcal{B}(b \to D_s^+ D_s^- X)$	$(1.17 \pm 0.71)\%$			0.38	[23]
$\mathcal{B}(b \to D^0 \bar{D} X)$	$(6.45 \pm 2.08)\%$	0.85			[23]
$\mathcal{B}(b \to D^+ \bar{D} X)$	$(1.8 \pm 0.96)\%$		0.52		[23]
$\mathcal{B}(b \to D_s^+ \bar{D} X)$	$(1.17 \pm 0.71)\%$			0.43	
$D_{(s)}$ meson background		0.05	0.01	0.10	
Combinatorial background		0.22	0.35	0.05	
Acceptance correction		0.25	0.25	0.02	
$\mathcal{B}(b \to D^0, \bar{D}^0 X)$	$(60.5 \pm 3.2)\%$	0.35			[1]
$\mathcal{B}(b \to D^{\pm} X)$	$(23.7 \pm 2.3)\%$		0.26		[1]
$\mathcal{B}(b \to D_s^{\pm} X)$	$(18 \pm 5)\%$			2.85	[1]
Total		0.99	0.79	2.91	

Table 7.4: Breakdown of the systematic error on $\mathcal{B}(b \to \bar{D}^0 X)$, $\mathcal{B}(b \to D^- X)$ and $\mathcal{B}(b \to D_s^- X)$. For the total, the different components have been added in quadrature.



RESULTAT

Channel	$Br(b \to D_{(s)}, \bar{D}_{(s)} X)(\%)$	ε_W (%)	ε_R (%)	$Br(b \to \bar{D}_{(s)} X)(\%)$
$b \to D^0 X$ $b \to D^- X$ $b \to DX$	60.5 ± 3.2 23.7 ± 2.3	17.7 9.9	19.3 12.4	6.6±1.3±1.0 2.7±1.1±0.8 9.3±1.7±1.3±0.4(Br)
$b \to D_S^- X$	18 ± 5	19.6	19.4	10.1±1.1±0.6±2.8(Br)

Letzter Wert kompatibel mit CLEO bei Y(4S):

$Br(b \to \bar{D}_{(s)} X) = 10.0 \pm 2.5\ \%$ (vorwiegend wrong sign)

$n_c = 1 + Br(b \to \bar{D}_{(s)} X) - Br(b \to \text{no charm}) + 2\, Br(b \to (c\bar{c})X)$

3.3% (DELPHI) $b \to J/\psi X$:2.4%

$n_c = 1.211 \pm 0.044$