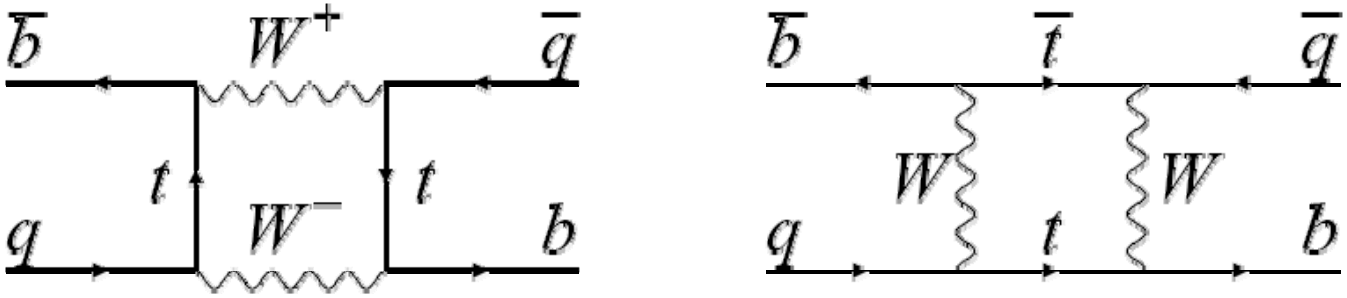


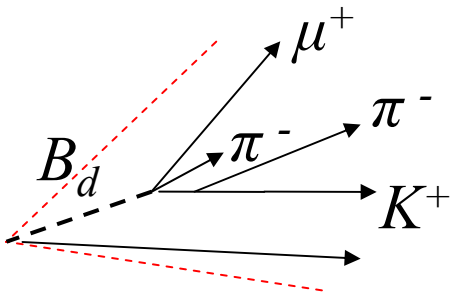
B_d mixing measurement using Opposite-side Flavour Tagging at DØ

- Data samples
- Making a B^0 mixing measurement
- Flavour Tagging method
- Extracting Δm_d and dilution
- Results of study

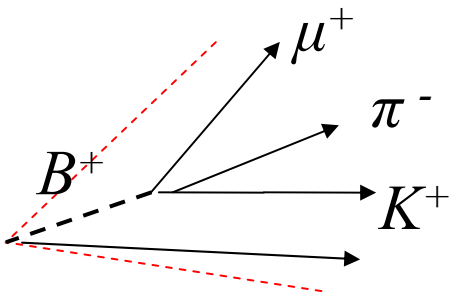
Data Samples (~1fb^{-1})

Look at semileptonic decays: $B \to \mu^+ \nu \bar{D}^0 X$

B^0_d sample
(oscillations)



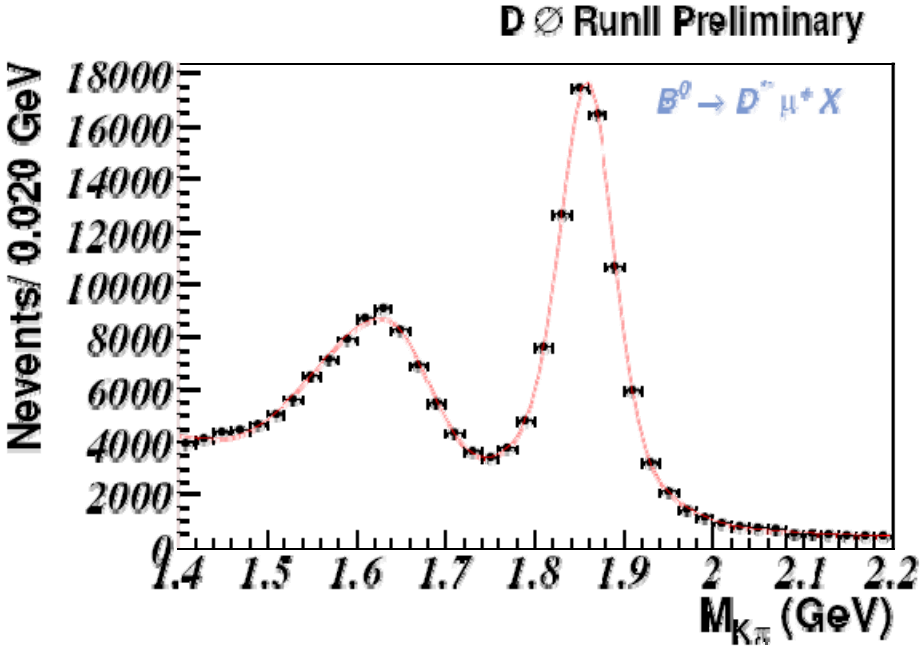
B^+ sample
(no oscillations)

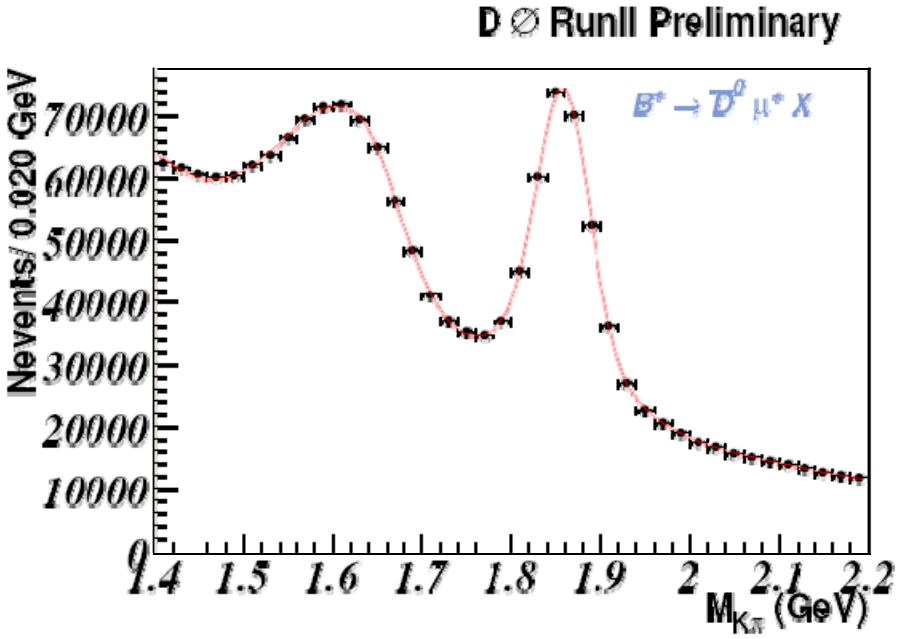


$$B^0_d \to D^{*-} \mu^+ \upsilon^\mu$$
$$D^{*-} \to \bar{D}^0 \pi^-$$
$$\bar{D}^0 \to K^+ \pi^-$$

$$B^+ \to \bar{D}^0 \mu^+ \upsilon^\mu$$
$$\bar{D}^0 \to K^+ \pi^-$$

Data Samples (~1fb^{-1})





$B \to \mu^+ D^{*-} X$		
B+	**B^0**	B^0_s
10%	**89%**	1%

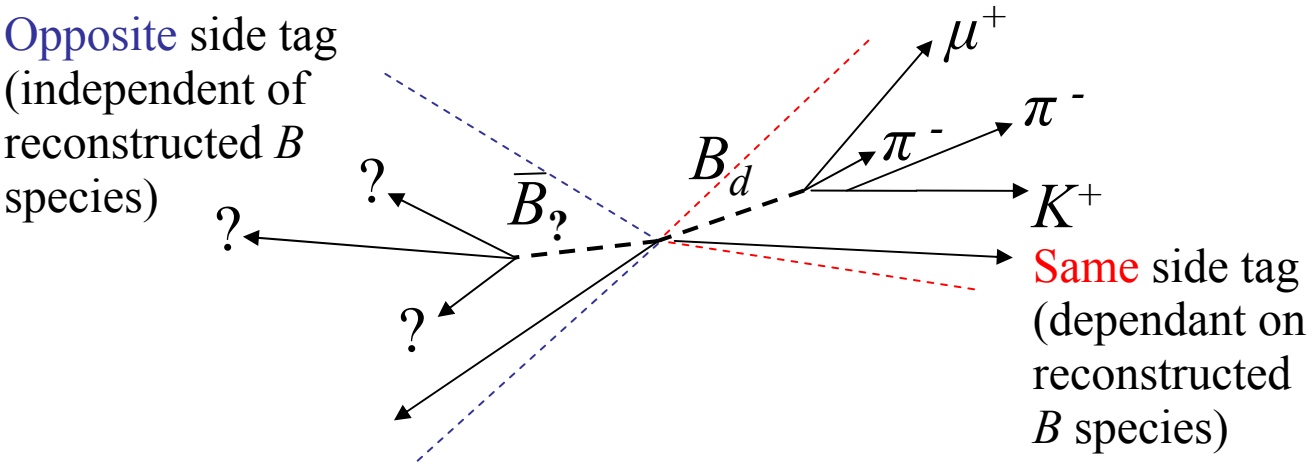
74,000 events

$B \to \mu^+ \overline{D}^0 X$		
B+	B^0	B^0_s
83%	16%	1%

230,000 events

Making a B^0 mixing measurement

Asymmetry $A(t) = \frac{N_{unmixed}(t) - N_{mixed}(t)}{N_{unmixed}(t) + N_{mixed}(t)}$



Inputs to mixing measurement: **initial state tag, final state tag, lifetime**

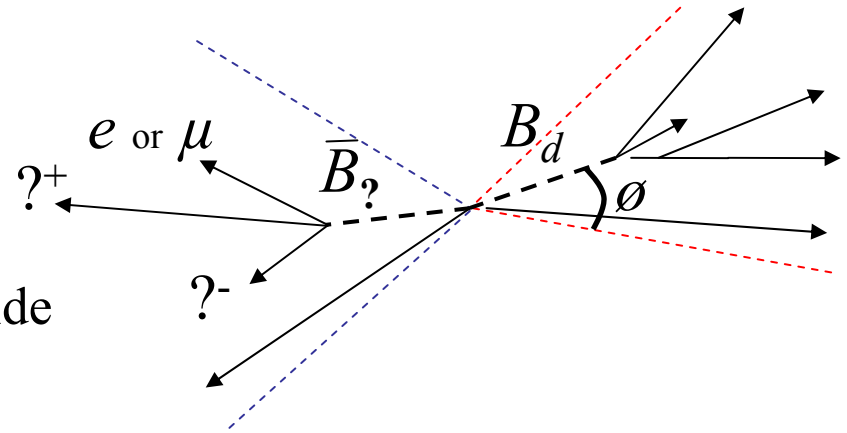
Efficiency $\varepsilon = \frac{N_{tag}}{N_{total}}$ Dilution $D = 1 - 2P_{\text{mistag}}$

tagging power $\propto \varepsilon D^2$

Construction of opposite side flavour tag

Opposite side Tags:

exclude: reconstructed tracks
tracks with cos ø > 0.8
→ tags independent of reconstructed side

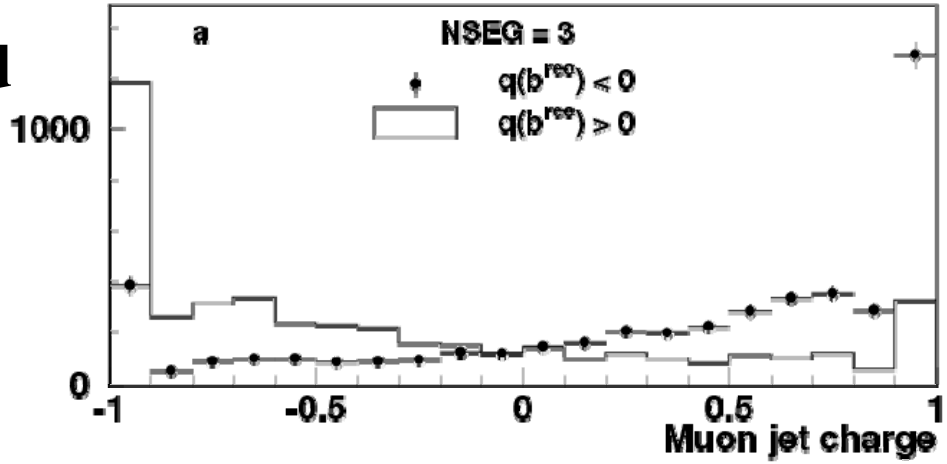


tag	quantity	Comments
Lepton jet charge (μ, e) $\bar{b} \to Xl^+, b \to Xl^-$	$Q_J^l = \frac{\sum_i q^i p_T^i}{\sum_i p_T^i}$	angular cut w.r.t. lepton: $\Delta R = \sqrt{(\Delta\phi)^2 + (\Delta\eta)^2} < 0.5$
Secondary vertex charge	$Q_{SV} = \frac{\sum_i (q^i p_L^i)^k}{\sum_i (p_L^i)^k}$	$k = 0.6$ gives optimal performance
Event charge	$Q_{EV} = \frac{\sum_i q^i p_T^i}{\sum_i p_T^i}$	momentum cut: $0.5 < p_T < 50$ GeV

Construction of opposite side flavour tag

tag variables → flavour likelihood

using PDFs from study of non-oscillating events (98% non-osc)



Combine likelihoods:

If	Use	Efficiency (estimated dil > 0.3)
μ found	μ jet charge × S.V. charge (if S.V. found)	6.6 %
e found	*e* jet charge × S.V. charge (if S.V. found)	1.8 %
S.V. found	S.V. charge × event charge	2.8 %

→ final flavour tag, with estimated dilution

Fitting procedure

- Split into bins of proper decay time (VPDL).
- In each bin fit $N_{unmixed}$ and N_{mixed} to find asymmetry.

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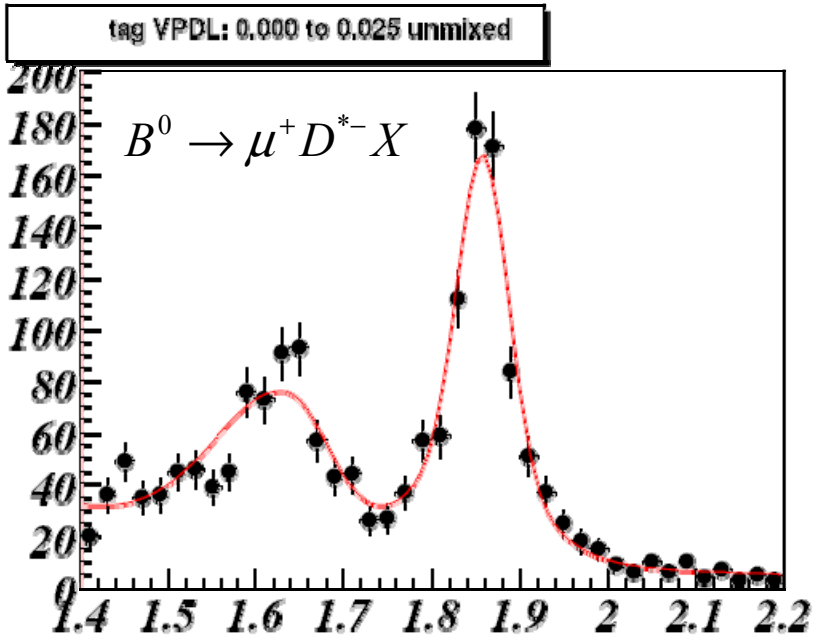

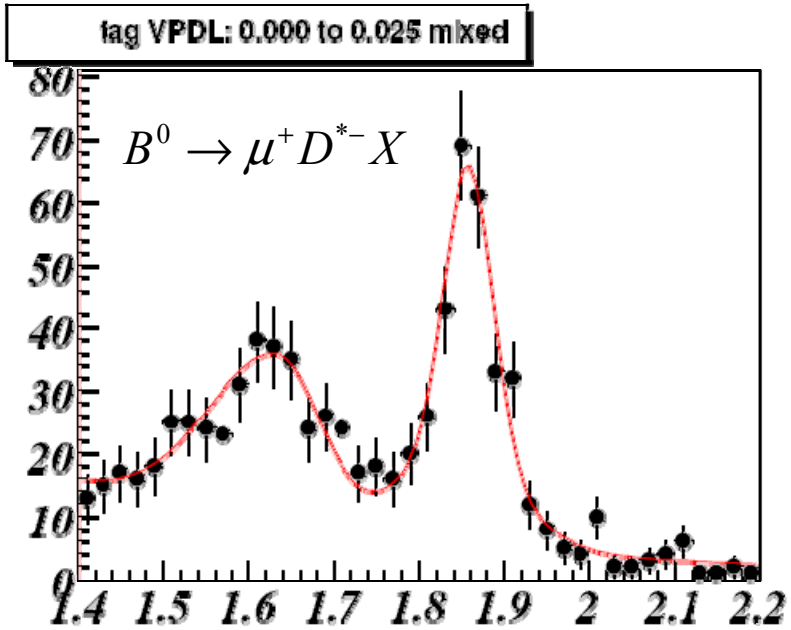

$$\text{Asymmetry} = \frac{N_{unmixed} - N_{mixed}}{N_{unmixed} + N_{mixed}}$$

Fitting procedure

- Split into bins of proper decay time (VPDL).
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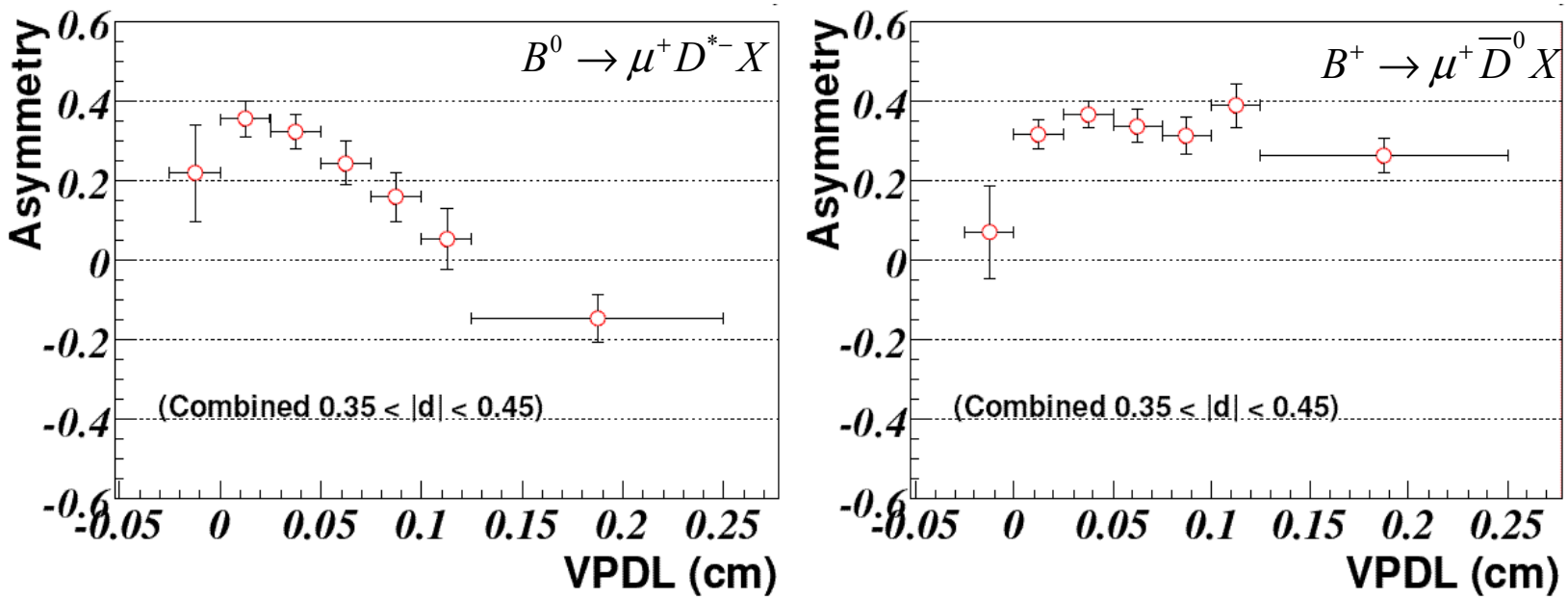

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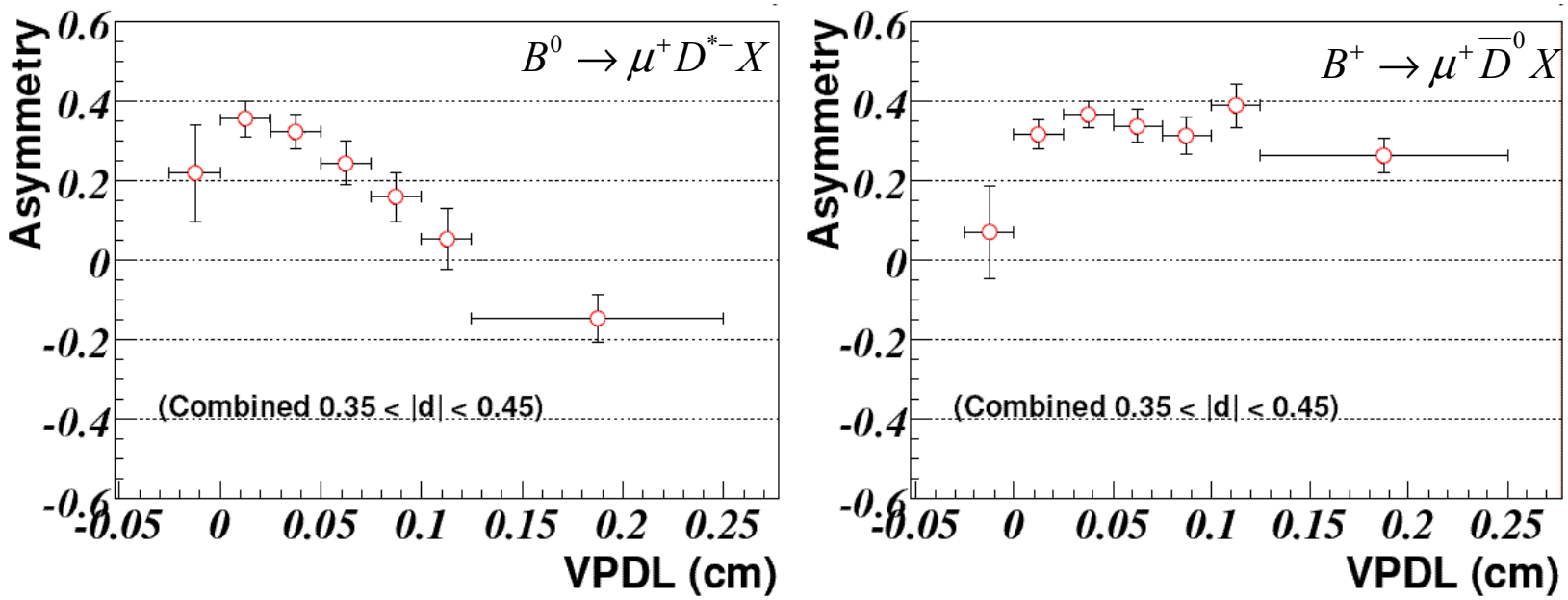
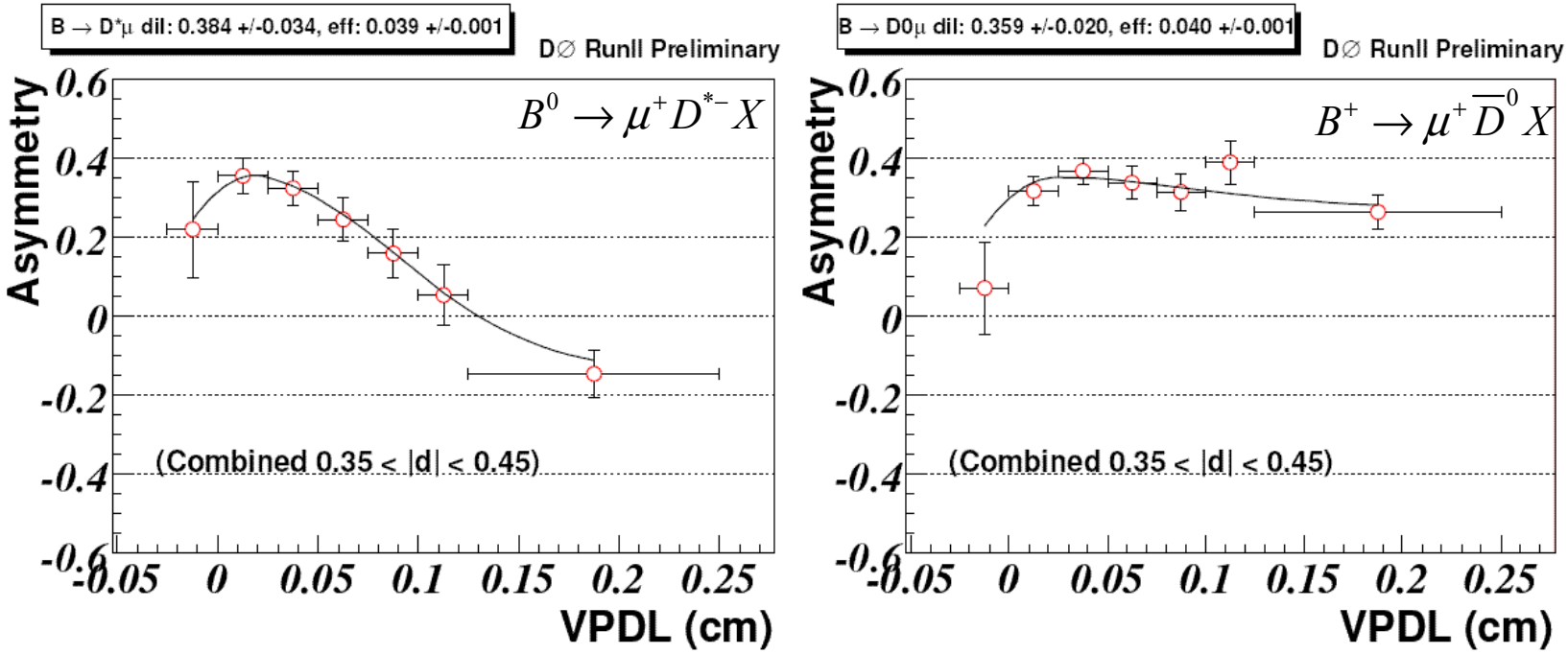


Fit asymmetries to find Δm_d and **tag dilution**

(inputs: branching ratios, detector resolution, reconstruction efficiencies, k-factors, charm contamination)

Fitting procedure

- Split into bins of proper decay time (VPDL).
- In each bin fit $N_{unmixed}$ and N_{mixed} to find asymmetry.

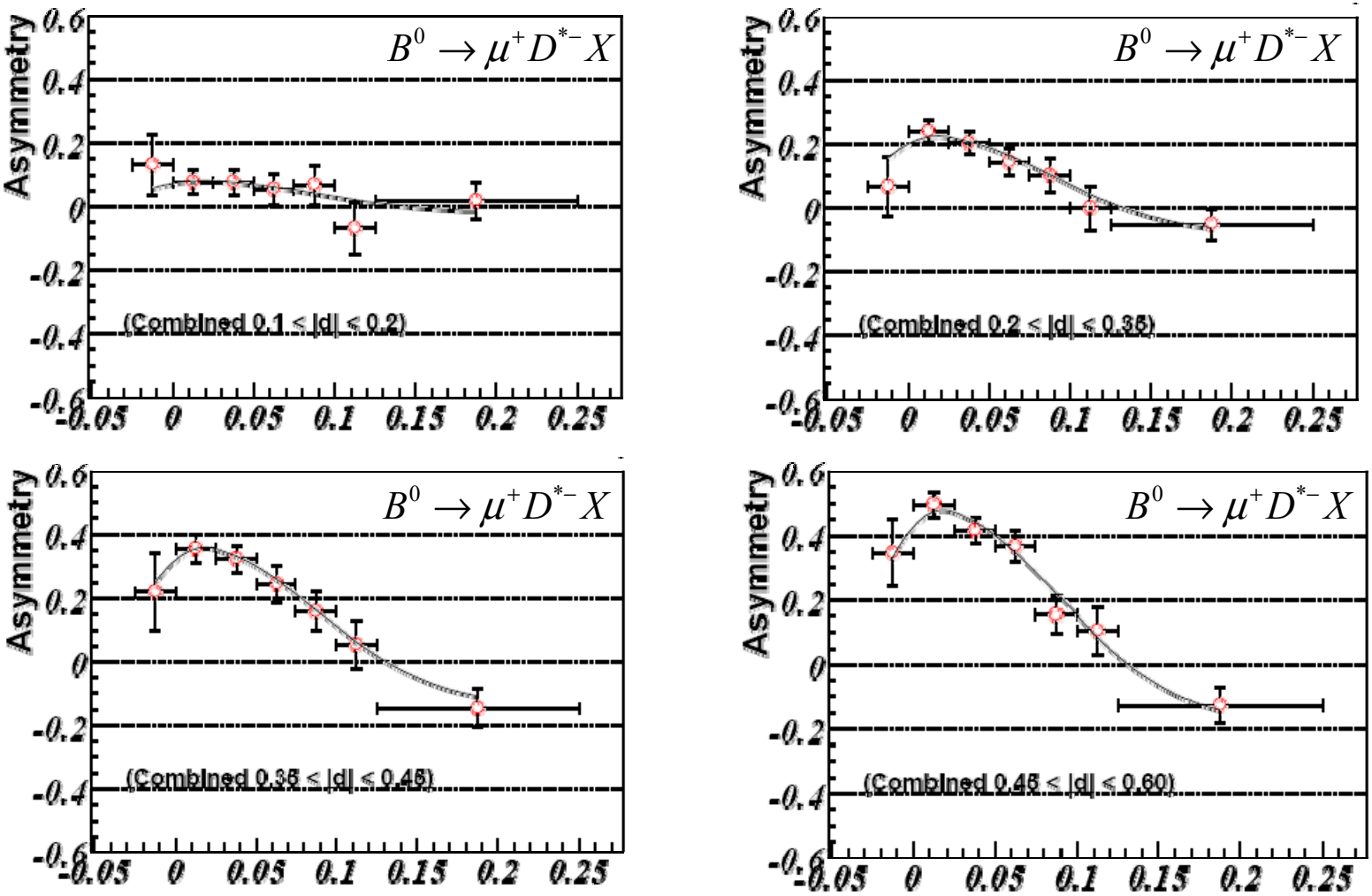


Fit asymmetries to find Δm_d and **tag dilution**

(inputs: branching ratios, detector resolution, reconstruction efficiencies, k-factors, charm contamination)

Fitting procedure

Simultaneously fit in 5 bins of dilution for best measurement of Δm_d



Results

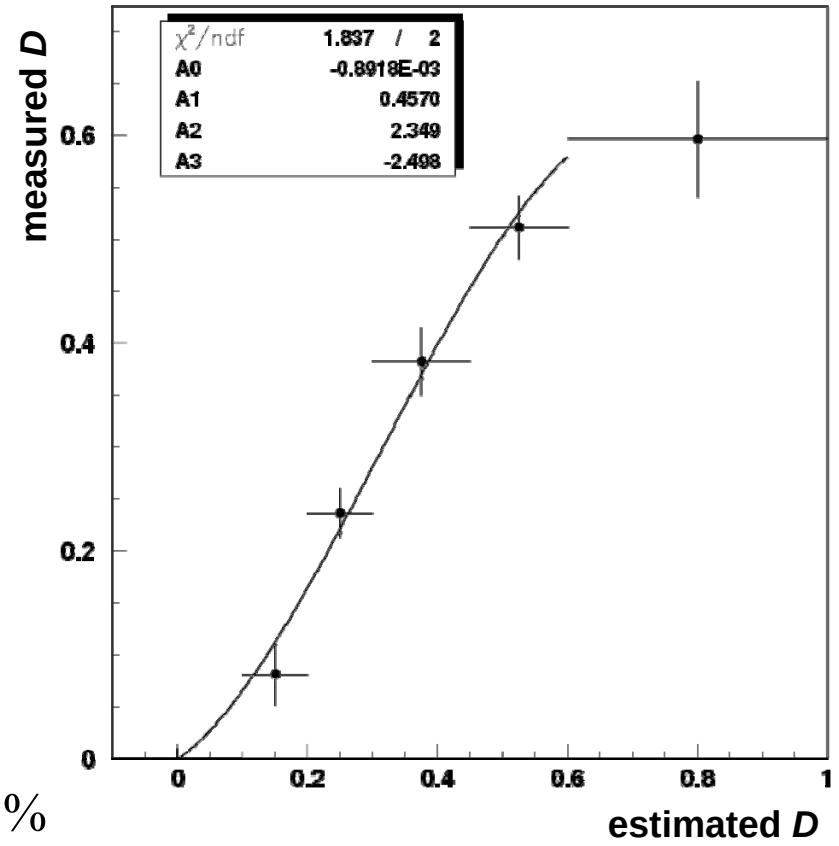
Mixing measurement:

$$\Delta m_d = \mathbf{0.506} \pm 0.020\ (\text{stat}) \pm 0.016\ (\text{sys})\ \text{ps}^{-1}$$

c.f. world average $\Delta m_d = 0.509 \pm 0.004\ \text{ps}^{-1}$

Calibrated tag dilution:

estimated *D*	**measured *D***	
	B^+ events	B_d^0 events
$0.10 < d < 0.20$	0.079 ± 0.029	0.104 ± 0.017
$0.20 < d < 0.30$	0.212 ± 0.024	0.234 ± 0.014
$0.30 < d < 0.45$	0.364 ± 0.032	0.361 ± 0.018
$0.45 < d < 0.60$	0.489 ± 0.030	0.504 ± 0.016
$d > 0.60$	0.572 ± 0.056	0.498 ± 0.031



Tagging power:

$$\varepsilon D^2 = \mathbf{2.48} \pm 0.21\ (\text{stat}) \pm 0.08\ (\text{syst})\ \%$$

Summary

B_d mixing has been measured, and is compatible with the world average result: $\Delta m_d = 0.506 \pm 0.020$ (stat) ± 0.016 (sys) ps^{-1}

The measured dilutions for B^+ and B^0 events are in agreement, as expected for the opposite side tagging method.

The calibrated dilution is an essential input in the B_s amplitude analysis.

The power of the combined opposite side tagger is measured to be: $\varepsilon D^2 = 2.48 \pm 0.21$ (stat) ± 0.08 (syst) %