B Physics at CDF

- Decays with 2 muons
- Hadronic B decays
- Something completely different: Pentaquarks

Moriond/EWK 2004. Jonas Rademacker, CDF
- New Si microstrip detector → excellent time resolution
- B triggers include
  - $\mu\mu$ Trigger: finds $B \rightarrow J/\psi X$
  - Displaced Track Trigger: finds B's (and charm)!

$B_d \rightarrow J/\psi K^*$ event at CDF
Measured $b$ X-sections at CDF:

Extract $b$-fraction in $J/\psi(\mu\mu)$ data from fit to $L_{xy}$

$L_{xy} = \text{projection of decay distance onto } \vec{p}$. 

$J/\psi$ from B’s have long, positive $L_{xy}$, prompt $J/\psi$ symmetric, centered on 0.

$$\sigma(p\bar{p} \rightarrow \bar{b}X |y| < 1.0) = 29.4 \pm 0.6 \pm 6.2 \mu b$$
**Lifetime (ratios) and Heavy Quark Expansion**

- HQE frequently used to relate measurements to CKM parameters e.g. B.R. of $B \rightarrow \ell \nu X$ to $|V_{cb}|, |V_{ub}|$ (see talks this morning).

- Need to be sure this tool works!

- HQE gives precise predictions for B-hadron lifetime ratios - good testing ground.

**HQE predictions for B lifetimes**

\[
\begin{align*}
\tau(B_{c}) & \ll \tau(\Xi_{b}^{0}) \\
& \sim \tau(\Lambda_{b}) \sim \tau(B_{d}^{0}) \sim \tau(B_{s}^{0}) < \tau(B^{-}) \\
& < \tau(\Xi_{b}^{-}) < \tau(\Omega_{b})
\end{align*}
\]

- $\tau(B^{-})/\tau(B_{d}^{0}) = 1.067 \pm 0.027$
- $\tau(B_{s})/\tau(B_{d}^{0}) = 0.998 \pm 0.015$
- $\tau(\Lambda_{b})/\tau(B_{d}^{0}) = 0.9 \pm 0.05$
Lifetimes in $\mu\mu$ Trigger $B \to J/\psi(\mu\mu)X$ fully reco'ed

- Signal: $\exp \otimes$ Gauss.
- Bckg model: (prompt $+$ 1 negative and 2 positive exp) $\otimes$ Gauss.
- Use mass fit for evt-by-evt S/B.
- Unbinned fit with $\mathcal{L} = \mathcal{L}(\tau, \text{mass})$

$\sim 2.4 \, k \, B^+ \to J/\psi K^*(\ast)^+ \quad \sim 1.6 \, k \, B^0 \to J/\psi K^*(\ast)^0, \, 195 \, pb^{-1}$

- $\tau_{B^+} = 1.66 \pm 0.04 \pm 0.02 \, \text{ps}$
- $\tau_{B^0} = 1.49 \pm 0.05 \pm 0.03 \, \text{ps}$
- $\tau_{B^+}/\tau_{B^0} = 1.12 \pm 0.046 \pm 0.014$
Lifetime $B_s \rightarrow J/\psi \phi$ $B \rightarrow J/\psi(\mu\mu)X$ fully reco’ed

Result for 138 pb$^{-1}$

- $\tau_{B_s} = 1.33 \pm 0.14 \pm 0.02$ ps
- $\tau_{B_s}/\tau_{B^0} = 0.88 \pm 0.11$ (stat)
  
- Note: Measurement dominated by CP-even component.

- Comes in 3 angular momentum states, 2 CP-even, 1 CP-odd.
- Can be disantangled by angular analysis. $\Rightarrow$ measure $\Delta \Gamma_s$.
- ...with more statistics.

...with more statistics.
CDF Run II Results: Lifetime Ratios (prelim)

\[ B_u^+ \rightarrow J/\psi(\mu^+\mu^-)K^{(*)+}, \ B_d^0 \rightarrow J/\psi(\mu^+\mu^-)K^{(*)0}, \ B_s^0 \rightarrow J/\psi(\mu^+\mu^-)\phi, \ \Lambda_b \rightarrow J/\psi(\mu^+\mu^-)\Lambda \]

<table>
<thead>
<tr>
<th></th>
<th>Run I</th>
<th>WAv:</th>
<th>HQE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\tau(B_u^+)/\tau(B_d^0))</td>
<td>1.12 ± 0.05</td>
<td>1.091 ± 0.050</td>
<td>1.086 ± 0.017</td>
</tr>
<tr>
<td>(\tau(B_s^0)/\tau(B_d^0))</td>
<td>0.88 ± 0.11</td>
<td>0.899 ± 0.072</td>
<td>0.951 ± 0.038</td>
</tr>
<tr>
<td>(\tau(\Lambda_b^0)/\tau(B_d^0))</td>
<td>0.91 ± 0.20</td>
<td>0.835 ± 0.11</td>
<td>0.797 ± 0.053</td>
</tr>
</tbody>
</table>

Run II \(B_u^+/B_d\) from 195 pb\(^{-1}\)
Run II \(B_s/B_d\) from 138 pb\(^{-1}\)
Run II \(\Lambda_b/B_d\) from 65 pb\(^{-1}\)

Run I results: all channels combined. Run II (here): fully reconstructed \(J/\psi(\mu\mu)X\) only.

Approaching Run I precision. Tevatron-specific: \(B_s\) and \(\Lambda_b\) lifetimes.

Run IIa will provide real test of HQE.
Search For $B_s \rightarrow \mu^+\mu^-$, $B_d \rightarrow \mu^+\mu^-$

High Sensitivity to New Physics

$\text{SM BR} \sim 10^{-9}$

Many extension of SM (mSUGRA, SO(10)) predict enhancements by several orders of magnitude.

- Observation $\Rightarrow$ New Physics.
- Else: Exclude some theories.

For example mSUGRA

- $\text{BR}(B_s \rightarrow \mu^+\mu^-) \approx 10^{-6}\tan^6 \beta \frac{M_{1/2}^2 \text{GeV}^4}{(M_{1/2}^2 + M_0^2)^3}$

- Connection to $a_\mu = \frac{(g-2)_\mu}{2}$:
  $\delta a_\mu \text{ SUSY} = a_\mu \text{ SUSY} - a_\mu \text{ SM}$
  $\propto \tan \beta \frac{f(M_0)}{M_{1/2}^2}$

Search For $B_s \to \mu^+\mu^-$, $B_d \to \mu^+\mu^-$

$\text{CDF II}$

Predicted Bg in search windows:

$B_d: 1.05 \pm 0.30$

$B_s: 1.07 \pm 0.31$

$\left\{1.75 \pm 0.34\right\}$

$Bkg = N(c\tau, \Delta \Phi) \cdot R(\text{Iso}) \cdot R(\text{mass})$

X-check Bg-predictions in $\mu^+\mu^+$, $\mu^-\mu^-$ and $(\mu^+\mu^- \text{ with } c\tau < 0)$. Then unblind.
Search For $B_s \rightarrow \mu^+\mu^-$, $B_d \rightarrow \mu^+\mu^-$ in 171 pb$^{-1}$

Result: 1evt in overlap region

$$BR(B_d \rightarrow \mu^+\mu^-) < 1.5 \cdot 10^{-7} \ (90\% CL)$$

$$BR(B_s \rightarrow \mu^+\mu^-) < 5.8 \cdot 10^{-7} \ (90\% CL)$$

Prev. best limits: $B_d$: $1.6 \cdot 10^{-7}$ (BELLE 2003) $B_s$: $2 \cdot 10^{-6}$ (CDF Run I)
$B_s \rightarrow \mu\mu$, $(g-2)_\mu$, and mSUGRA.

Black $\text{BR}(B_s \rightarrow \mu\mu)$.
Green $\frac{\delta a_\mu}{10^{-10}}$
Red Mass of (lightest) Higgs (GeV)

For $\tan\beta = 50$, $A_0 = 0$, $\mu > 0$, $m_t = 175$ GeV

Inching into the allowed parameter space of mSUGRA.
Displaced Track Trigger

- 3 Level Trigger: $2.5 \text{ MHz} \rightarrow L1 \rightarrow 15 \text{ kHz} \rightarrow L2 \rightarrow 300 \text{ Hz} \rightarrow L3 \rightarrow 50 \text{ Hz} \Rightarrow$ throw away 99.998% of all events.

- Need to make sure that those 0.002% we keep are carefully selected.

$\nu_{\text{vtx}} \approx 1/2\text{mm}$

$B$ Trigger

- Traditionally: Trigger on $\ell(e, \mu)$. Works well - see results on previous slides.

- Excludes important $B$ decays, like $B^0_d \rightarrow \pi^+\pi^-$. 

- Run 2: First time in a hadron collider: Use “long” $B$ lifetime. 

Trigger on Impact Parameter at $L2$ (2 tracks, $\text{IP} > 100 \mu$).
Displaced Track Trigger

SVT Impact Parameter distribution

\( \sigma = 48 \ \text{\mu m} \) (includes 33\,\mu m beam spot)

900 \( B \to hh \) events for 190 pb\(^{-1}\)

(\( B_d^0 \to \pi\pi \), \( B_s^0 \to KK \), etc)
Disentangling $B \rightarrow hh$

**Challenge:** Separate $B_d^0 \rightarrow \pi\pi$, $B_s^0 \rightarrow KK$ and other $B \rightarrow hh$

1.16$\sigma$ $K/\pi$ sep. from $\frac{dE}{dx}$ (Data)

Mass vs $(1 - p_1/p_2) \cdot Q_1$. (Monte Carlo)
$B_0^d \rightarrow hh$ Results for 65 pb$^{-1}$, and prospects

- First observation of $B_S \rightarrow KK$: 90 $\pm$ 24 out of 300 $B \rightarrow hh$ events (65 pb$^{-1}$).

- Search for $CP$ in time-integr. rates:
  
  \[ A_{CP} = \frac{\Gamma(\bar{B}_0^d \rightarrow K^-\pi^+) - \Gamma(B_0^d \rightarrow K^+\pi^-)}{\Gamma(\bar{B}_0^d \rightarrow K^-\pi^+) + \Gamma(B_0^d \rightarrow K^+\pi^-)} \]
  
  \[ = 0.02 \pm 0.15 \pm 0.017 \]

- \[ \frac{\Gamma(B_0^d \rightarrow \pi^+\pi^-)}{\Gamma(B_0^d \rightarrow K^\pm\pi^\mp)} = 0.26 \pm 0.11 \pm 0.06 \]

- Analysed $\sim 3 \times$ as much data $\rightarrow$ Improved results, soon.

- Long term: Time dependent decay rate asymmetries in $B_d \rightarrow \pi\pi$ and $B_S \rightarrow KK$ allow extraction of $CP$ phase $\gamma$. 

- Analysed $\sim 3 \times$ as much data $\rightarrow$ Improved results, soon.
**Loads of Charm - \(D^0 \rightarrow hh\)**

\(D^0\) from \(D^{*+} \rightarrow D^0\pi\): *Clean signal, distinguish \(D^0\), \(\bar{D}^0\).* For 123 pb\(^{-1}\)

\[
\begin{align*}
D^{*+} &\rightarrow D^0(K^\mp\pi^\mp)\pi^+ & D^{*+} &\rightarrow D^0(K^+K^-)\pi^+ \\
\Gamma(D^{*+} \rightarrow D^0(K^\mp\pi^\mp)\pi^+) &\quad \Gamma(D^{*+} \rightarrow D^0(K^+K^-)\pi^+) \\
\Gamma(D^0 \rightarrow K^+K^-) &\quad \Gamma(D^0 \rightarrow K^\mp\pi^\mp) \\
\end{align*}
\]

- \(A_{CP\ KK} = \Gamma(\bar{D}^0 \rightarrow K^+K^-) - \Gamma(D^0 \rightarrow K^+K^-)\)
  \[\Gamma(\bar{D}^0 \rightarrow K^-K^+) + \Gamma(D^0 \rightarrow K^+K^-)\]
  \[= 2.0\% \pm 1.2\% \pm 0.6\%\]

- \(A_{CP\ \pi\pi} = \Gamma(\bar{D}^0 \rightarrow \pi^+\pi^-) - \Gamma(D^0 \rightarrow \pi^+\pi^-)\)
  \[\Gamma(\bar{D}^0 \rightarrow \pi^-\pi^+) + \Gamma(D^0 \rightarrow \pi^+\pi^-)\]
  \[= 1.0\% \pm 1.2\% \pm 0.6\%\]

\[
\begin{align*}
\Gamma(D^0 \rightarrow K^+K^-) &\quad \Gamma(D^0 \rightarrow K^\mp\pi^\mp) \\
9.96\% &\pm 0.11\% \pm 0.12\% & 3.608\% &\pm 0.054\% \pm 0.12\% \\
\Gamma(D^0 \rightarrow K^+K^-) &\quad \Gamma(D^0 \rightarrow \pi^+\pi^-) \\
2.762\% &\pm 0.040\% \pm 0.034\% &
\end{align*}
\]

\(88.3\ k \pm 0.3\ k\) \hspace{1cm} \(8.19\ k \pm 0.14\ k\)
$B^0_s \rightarrow D_S \pi$

CDF Run II Preliminary, $L = 119 \, \text{pb}^{-1}$

$N(B^0_s) = 84 \pm 11$

- Flavour eigenstate
- No missing momentum (unlike $B^0_s \rightarrow D_S \ell \nu$), good time resolution ($\sigma(\tau)$ in topol. similar decays: 67 fs). Needs hadron trigger.
- CDF’s “golden mode” for mixing.
- 80 $B^0_s \rightarrow D_S (\phi \pi) \pi$ evts for $119 \, \text{pb}^{-1}$, $S/B \sim 2$. Note: efficiency improved. Now $\sim 1.6 \, \text{evts/pb}^{-1}$.

No $B_S$ mixing result, yet. B.R. instead:

$$\frac{f_s \cdot BR(B^0_s \rightarrow D^- \pi^+)}{f_d \cdot BR(B^0_d \rightarrow D^- \pi^+)} = 0.35 \pm 0.05 \pm 0.04 \pm 0.09 (BR)$$
Pentaquarks
Looking for $\Xi^0(1860) \rightarrow \Xi^- \pi^+$ and $\Xi^- \rightarrow \Xi^- \pi^-$ with $\Xi^- \rightarrow \Lambda(p\pi)\pi^-$, found by NA49 (hep-ex/0310014)

$1^{st}$ Step: $\Xi^-$ reconstruction

- $\Xi^-$ is very long lived - yet another job for the displaced track trigger. Find 36,000 $\Xi^-$.  
- $\Xi^-$ lives long enough to leave hits in Si Detector. Requiring hits from the $\Xi^-$ in the Si provides extremely clean $\Xi^-$ signal.
Pentaquarks

Looking for $\Xi(1860) \rightarrow \Xi^{-}\pi^{\pm}$

2$^{nd}$ Step: Combine $\Xi^{-}$ with $\pi^{\pm}$

Normalise by known $\Xi^{0}(1530) \rightarrow \Xi^{-}\pi^{+}$.

- Don't see any $\Xi(1860)$
- It's not statistics: (18× as many $\Xi^{-}$ as NA49).
- Unknown bias due to Trigger?
  Re-check with Jet20 data (2× NA49). Still no $\Xi(1860)$

95% UL relativ to $\Xi(1530)$:

$\Xi^{-}\pi^{+}(1860) / \Xi(1530) = 0.07$

$\Xi^{-}\pi^{-}(1860) / \Xi(1530) = 0.04$
Summary
Plenty of B at Tevatron. Only source of B\(_s\), Λ\(_b\).

**Lepton Trigger**

- \(\sigma(p\bar{p} \rightarrow bX)\)
- Precise \(\tau_B\) in \(B \rightarrow J/\psi X\). 1\(^{st}\) step towards \(\Delta \Gamma_s\), test HQE.
- Best limits for \(B_{d,s} \rightarrow \mu\mu\). Highly sensitive probe of New Physics.

**Hadron Trigger**

- Unique sample of \(B \rightarrow hh\), \(B \rightarrow D\pi\)
- 1\(^{st}\) observation of \(B_s \rightarrow KK\).
- Lots of Charm.
- Future: \(\Delta \Gamma_s\), \(\Delta m_s\), \(\not\!CP\) with \(B_s \rightarrow KK\) & \(B_d \rightarrow \pi\pi\)

- Pentaquarks: Didn’t see Ξ(1840)
  ... will look for others, especially D or \(J/\psi +\) Baryon.
Summary B Physics at DØ and CDF

**Lepton Trigger**
- Plenty $B \rightarrow J/\psi X$, $B \rightarrow \ell \nu X$, for $\sigma(p \bar{p} \rightarrow bX)$, B.R. $B \rightarrow D^{**}$, precise $\tau$ for $B^+, B_d, B_s, \Lambda_b$.
- Best limits for $B_{d,s} \rightarrow \mu\mu$ from CDF, DØ result with similar precision, soon. Highly sensitive probe of New Physics.
- Flavour tagging and $B_d$ mixing results from DØ.

**Hadron Trigger**
- Unique sample of $B \rightarrow hh$, $B \rightarrow D\pi$. 1st observation of $B_s \rightarrow KK$, Lots of Charm.
- DØ’s displaced track trigger is being commissioned.
- Pentaquarks: Didn’t see $\Xi(1840)$. Will look for others, especially D or $J/\psi +$ Baryon.

Penty of B results at both experiments. Beginning to seriously probe SM. More B physics of all flavours, soon.
BACKUP SLIDES
two cuts:
- $p(\pi^+) > 3$ GeV/c
- opening angle between $\Xi$ and $\pi$ greater than 4.5°
\[ r_{\text{NA49}}^{0} = \frac{\#(\Xi(1860))}{\#(\Xi(1530))} = \frac{\sigma(pp \rightarrow \Xi(1860)) \cdot Br(\Xi(1860) \rightarrow \Xi^{-} \pi^{+}) \cdot a(\Xi(1860))}{\sigma(pp \rightarrow \Xi(1530)) \cdot a(\Xi(1530))} \sim 0.21, \] (1)

\[ r_{\text{NA49}}^{-} = \frac{\#(\Xi(1860))}{\#(\Xi(1530))} = \frac{\sigma(pp \rightarrow \Xi(1860)) \cdot Br(\Xi(1860) \rightarrow \Xi^{-} \pi^{+}) \cdot a(\Xi(1860))}{\sigma(pp \rightarrow \Xi(1530)) \cdot a(\Xi(1530))} \sim 0.24, \] (2)

\[ r_{\text{NA49}}^{-} = \frac{\#(\Xi(1860))}{\#(\Xi(1530))} = \frac{\sigma(pp \rightarrow \Xi(1860)) \cdot Br(\Xi(1860) \rightarrow \Xi^{-} \pi^{+}) \cdot a(\Xi(1860))}{\sigma(pp \rightarrow \Xi(1530)) \cdot a(\Xi(1530))} \sim 0.45 \] (3)

\[ \frac{\sigma(pp \rightarrow \Xi(1530)) \cdot a(\Xi(1530))}{\sigma(pp \rightarrow \Xi) \cdot a(\Xi)} \sim 0.068 \] (4)
The B_S System

- Two CP-eigenstates with different mass and lifetime. Measure both \( \Delta \Gamma_s \) and \( \Delta m_s \) at CDF.
- \( \Delta \Gamma_s \) from lifetimes in \( B^0_S \rightarrow D_S D_S \), \( B^0_S \rightarrow K K \), \( B^0_S \rightarrow J/\psi \phi \)
- 1\textsuperscript{st} step towards \( \Delta \Gamma_s \): Average \( \tau \) in \( J/\psi \phi \) 1.33 \( \pm \) 0.14 ps
- \( \Delta m_s \) from \( B_S \) oscillations.

Status

- \( \Delta m_s = 15 – 30 \text{ ps}^{-1}, 95\% \text{ CL} \) (Direct limit + Unitarity Triangle, from CKM Fitter).
- Theory: \( \frac{\Delta \Gamma_s}{\Gamma_s} = 7\% \pm 4\% \)
- Exp: \( \frac{\Delta \Gamma_s}{\Gamma_s} < 0.31, 95\% \text{ CL} \)
- \( \frac{\Delta \Gamma_s}{\Delta m_s} = \frac{\pi}{2} \frac{m_b^2}{m_W^2} \left| \frac{V_{cb} V_{cs}}{V_{ts} V_{tb}} \right|^2 \times \text{QCD} \sim 2 \cdot 10^{-3} \)
- Sensitive to CKM and New Physics.
Tagging Strategies and Status

flavours at creation

fully reconstructed B

lepton Tag \( b \rightarrow \ell^- \)

Kaon Tag \( b \rightarrow c \rightarrow s \rightarrow K^- \)

Jet Charge \( \Sigma Q(\text{all trks in Jet}) \)

Same Side Tag:

Expect great things from Kaons: \( K/\pi \) sep. in Time Of Flight.

Measured Performances in Run II.
\( \varepsilon = \text{efficiency}, \quad \omega = \text{wrong-tag} \)
\( D = 1 - 2\omega \)

<table>
<thead>
<tr>
<th>Tag</th>
<th>( \varepsilon D^2 ) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \mu )</td>
<td>0.66 ± 0.09</td>
</tr>
<tr>
<td>( e )</td>
<td>in progress</td>
</tr>
<tr>
<td>( K_{\text{opp}} )</td>
<td>in progress</td>
</tr>
<tr>
<td>( Q_{\text{Jet}} )</td>
<td>in progress</td>
</tr>
<tr>
<td>( B_d: \pi_{\text{same}} )</td>
<td>1.9 ± 0.9</td>
</tr>
<tr>
<td>( B_s: K_{\text{same}} )</td>
<td>in progress</td>
</tr>
</tbody>
</table>

N events before tagging \( \sim \varepsilon D^2 \cdot N \) perfectly tagged events.
$\Delta m_S$ with $B^0_S \rightarrow D_S \pi$

Significance =

$$\sqrt{\frac{1}{2} S \varepsilon D^2} \sqrt{\frac{S}{S + B}} \exp\left((\Delta m_S \sigma_\tau)^2\right)$$

**Performance**

<table>
<thead>
<tr>
<th>Now</th>
<th>Expected Improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evt/Lumi</td>
<td>1.6 pb</td>
</tr>
<tr>
<td>S/B</td>
<td>$\sim 2$.</td>
</tr>
<tr>
<td>$\varepsilon D^2$</td>
<td>being studied</td>
</tr>
<tr>
<td>$\sigma(\tau)$</td>
<td>L00,PV $\Rightarrow$ 50 fs</td>
</tr>
</tbody>
</table>

Most important improvement: Better $\sigma(\tau)$ using innermost Si layer, and evt-by-evt prim. Vtx.
B production at Tevatron Run II

• $p\bar{p}$ collisions @ 1.96 TeV, $\sigma_{b\bar{b}} \sim 0.05$ mb

• Produce many $B^0, B_s, \Lambda_b, ...$ -- some picture

• Challenging: Messy environment ($\sigma(p\bar{p} \text{ inel}) \sim 100$ mb)
Silicon Vertex Trigger \textit{Impact Parameter trigger at L2}

Combines L1-tracks with Si-info to calculate IP.
\[ \sigma_{IP} = 48 \mu m = 0.35 \mu m(\text{intrinsic}) \oplus 0.33 \mu m(\text{beam-size}) \]

Finds lots of charm.
Use \( D^0 \to K\pi \) as online monitor for SVT.

2-Track Hadron Trigger

\textbf{L1:} 2 XFT tracks, \( p_t > 2 \text{ GeV}, \Delta\phi < 135^\circ \), \( p_{t1} + p_{t2} > 5.5 \text{ GeV} \).

\textbf{L2:}

- 2-body:
  - e.g. \( B^0_d \to \pi\pi \)
- Multi-body:
  - e.g. \( B^0_s \to D_S\pi \)

  | IP > 100 \mu m | IP > 120 \mu m |
  | 20^\circ < \Delta\phi < 135^\circ | 2^\circ < \Delta\phi < 90^\circ |
  | \( L_{xy} > 200 \mu m \) | \( L_{xy} > 200 \mu m \) |
  | IP of B < 140 \mu m | – |

\textbf{L3:} Same with refined tracks \& mass cuts.
 Silicon Vertex Detector

[Diagram showing the layout of the silicon vertex detector with labels for layers 00, SVX II, ISL, and various sections with φ angles and η values.]
Silicon Vertex Detector

- Layer 00 fully functional
- Cooling problem solved.
- Chip-failures in z-layers understood, can be prevented in future (no problems since Nov).
- Need to finalise Alignment: For now, ISL, Layer 00 and z-information not used (coming soon).

For “simple” $\tau$ measurements, SVX II in 2-D fully adequate. Improvement from L00, ISL, and z available soon, esp. for $\Delta m_s$, and to improve acceptance.