B physics in 2003:
The Standard Model can explain the magnitude of CP violation seen in the K and B systems.

B physics in 2013:
Will physics beyond the Standard Model also show up in the B system? If so, how will B physics results impact and complement LHC results?

Cosmology suggests SM CP violation is not the whole story. Also terrestrial hints, e.g. $B \rightarrow \phi K_s$ Many, but not all, beyond-SM models produce observable effects in B physics.
Mantra of B/LHC Complementarity

LHC will find new physics, and determine its mass scale. If it’s SUSY, it will determine flavor-diagonal squark mass terms.

B physics experiments will measure the flavor violation in new physics. If it’s SUSY, will determine flavor-off-diagonal squark mass terms.

Interpretation of B physics deviations within new physics models definitely requires knowing the mass scale (LHC):

\[ \text{deviations} = f(\text{new angles, new } \delta M^2, \text{new mass scale}). \]

10^{36} workshop to study complementarity more quantitatively by October. Also to address reach of \( 2 \times 10^{35} \) vs. \( 10^{36} \) vs. LHCb/BTeV.
### Comparison with BTeV/LHCb

**e^+e^- does relatively better if more:** vs, π^0s, tagging, or inclusive

<table>
<thead>
<tr>
<th>Feature</th>
<th>Quantity</th>
<th>Mode</th>
<th>2 x10^{35}</th>
<th>10^{36}</th>
<th>LHCb/BTeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side</td>
<td>V_{ub}</td>
<td>$B \rightarrow (\pi, \rho, X_\mu) \ell \nu$</td>
<td>🌟🌟🌟</td>
<td>🌟🌟🌟</td>
<td>-----</td>
</tr>
<tr>
<td>Angles</td>
<td>$\beta$ (vs.ref.)</td>
<td>$B \rightarrow \phi K_S$</td>
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<tr>
<td>Angles</td>
<td>$\alpha_{\text{eff}}$</td>
<td>$B \rightarrow \pi^+\pi^-$</td>
<td>🌟</td>
<td>🌟🌟🌟</td>
<td>🌟</td>
</tr>
<tr>
<td>Angles</td>
<td>$\alpha$</td>
<td>$B^0 \rightarrow \pi^0\pi^0$</td>
<td>🌟</td>
<td>🌟🌟🌟</td>
<td>-----</td>
</tr>
<tr>
<td>Angles</td>
<td>$\alpha$</td>
<td>$B^0 \rightarrow \rho\pi$</td>
<td>🌟</td>
<td>🌟🌟🌟</td>
<td>🌟🌟🌟</td>
</tr>
<tr>
<td>Angles</td>
<td>$\sim 0$</td>
<td>$B^0 \rightarrow (J/\psi)\eta^{(')}$</td>
<td>-----</td>
<td>-----</td>
<td>🌟🌟🌟</td>
</tr>
<tr>
<td>Angles</td>
<td>$\gamma$</td>
<td>$B_{(s)} \rightarrow D_{(s)} K$</td>
<td>🌟🌟🌟</td>
<td>🌟🌟🌟</td>
<td>🌟🌟🌟</td>
</tr>
<tr>
<td>Rare Decays</td>
<td>$C_{7,8,9,10}$</td>
<td>$B \rightarrow K^* l^+ l^-$</td>
<td>🌟🌟</td>
<td>🌟🌟🌟</td>
<td>🌟🌟🌟</td>
</tr>
<tr>
<td>Rare Decays</td>
<td>sign($C_7$)</td>
<td>$A_{FB}(B \rightarrow K^* l^+ l^-)$</td>
<td>-----</td>
<td>🌟🌟🌟</td>
<td>🌟🌟🌟</td>
</tr>
<tr>
<td>Rare Decays</td>
<td>Im($C_7 C_i^*$)</td>
<td>$A_{CP}(B \rightarrow K^* \gamma)$</td>
<td>🌟🌟🌟</td>
<td>🌟🌟🌟</td>
<td>🌟🌟🌟</td>
</tr>
</tbody>
</table>
Extrapolated statistical errors on $CP$ asymmetries

10 to 50 ab$^{-1}$ are required for a meaningful comparison

from D. Hitlin’s March 20 B day talk
Detector Upgrades

• Both Babar and Belle have started to look at upgrade paths to make the detectors $10^{36}$-capable
  – $10^{36}$ is quite different from $10^{35}$: current detectors could be stretched to work at $10^{35}$ with relatively minor changes. $10^{36}$ requires a lot of changes.
  – Main concerns are:
    • Machine-related backgrounds
      – synchrotron radiation
      – particle backgrounds, due primarily to continuous injection
    • Radiation dose
    • Physics backgrounds – hadronic split-offs, ….
Conclusions

$10^{36}$ has **huge** physics opportunities if there is new flavor physics. $10^{36}$ needed to compete head-to-head with LHCb/BTeV on most angle CP asymmetries.

However, $10^{36} = L_{\text{now}} \times 100$ is a **big step** for both machine and detector. (Previous factor of 1000 came largely from one source (1000 bunches).)

“Adiabatic approach” aiming at $2 \times 10^{35}$ could allow one to see how anomalies play out. Less $ up front ($0.2B vs. $0.5B??). This may be important if there is a linear collider in the US.

Timeliness with respect to LHC, LHCb and BTeV also important.

Of the large projects we have looked at, the $Y(4S)$ machines seem closest to having a complete design. Little synergy with LC technology though.