Summary

B Mixing and Lifetimes

Working Group 3

presented by Christoph M.E. Paus

Massachusetts Institute of Technology

B Workshop

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Outline

Quick summary of the new theory contributions

Touch on news in lifetime

Run down the projections for B_s^0 mixing

Summarize status of $\Delta\Gamma_{B_s^0}$ projections

Status of the Draft

Conclusions

News from Theory

NLO calculations (A. Lenz): lifetimes

Beneke, Buchalla, Greub, Lenz, Nierste

- predictions for $\Delta\Gamma_{B_s^0}/\Gamma = 0.16 \pm 0.07$
- uncertainty mainly due to bag parameters
- unquenched numbers: Give them CPU!!

Baryon Lifetimes (M. Voloshin): $\Xi_Q \to \Lambda_Q \pi$

- calculated with current algebra (PCAC)
- relatively small phase space
- contribution (surprisingly) large: $V_{us} \gg V_{cb}$
- $Br(\Xi_B \to \Lambda_B \pi) \approx 10 \cdot 10^{-3}$ and
  $Br(\Xi_C \to \Lambda_C \pi) \approx 3 \cdot 10^{-3}$
- ball in the court of experimentalists

Angular Analysis (A. Dighe):

Dighe, Dunietz, Fleischer, Lipkin, Rosner

- separate CP odd/even states in $B_s^0 \to J/\psi\phi$
- angular analysis crucial for $\Delta\Gamma_{B_s^0}$ measurement
- one angle 1996, 3 angle analysis 1999
- ball in the court of experimentalists

Lifetimes

New contributions: Λ_b^0 lifetime from DØ:

- ☞ decay mode: $\Lambda_b^0 \to J/\psi \Lambda^0 \to \mu^- \mu^+ p^+ \pi^-$
- ☞ trigger efficiency: 2.5-7.0%
- ☞ $Br(\Lambda_b^0 \to J/\psi \Lambda^0) = 4.7 \cdot 10^{-4}$
- ☞ Monte Carlo simulation using MCFast
- ☞ mass resolution 14 MeV
- ☞ lifetime resolution 0.16 ps
- ☞ expected yield: few thousand events

CDF might have extrapolations from Run I for the write up

B_s^0 Mixing Hadronic Decays

Standard Model expectations/limits:

- constraints: $22.0 < x_s < 30.8$

Studies from BTeV and CDF:

- golden mode: $B_s^0 \to D_s^- \pi^+$
  with $D_s^- \to \phi\pi^- \to K^+K^-\pi^-$
  with $D_s^- \to K^{*0}K^- \to K^+\pi^-K^-$
- BTeV also: $B_s^0 \to J/\psi K^{*0}$
  with $J/\psi \to \mu^+\mu^-$ and $K^{*0} \to K^-\pi^+$
- key features of analysis:

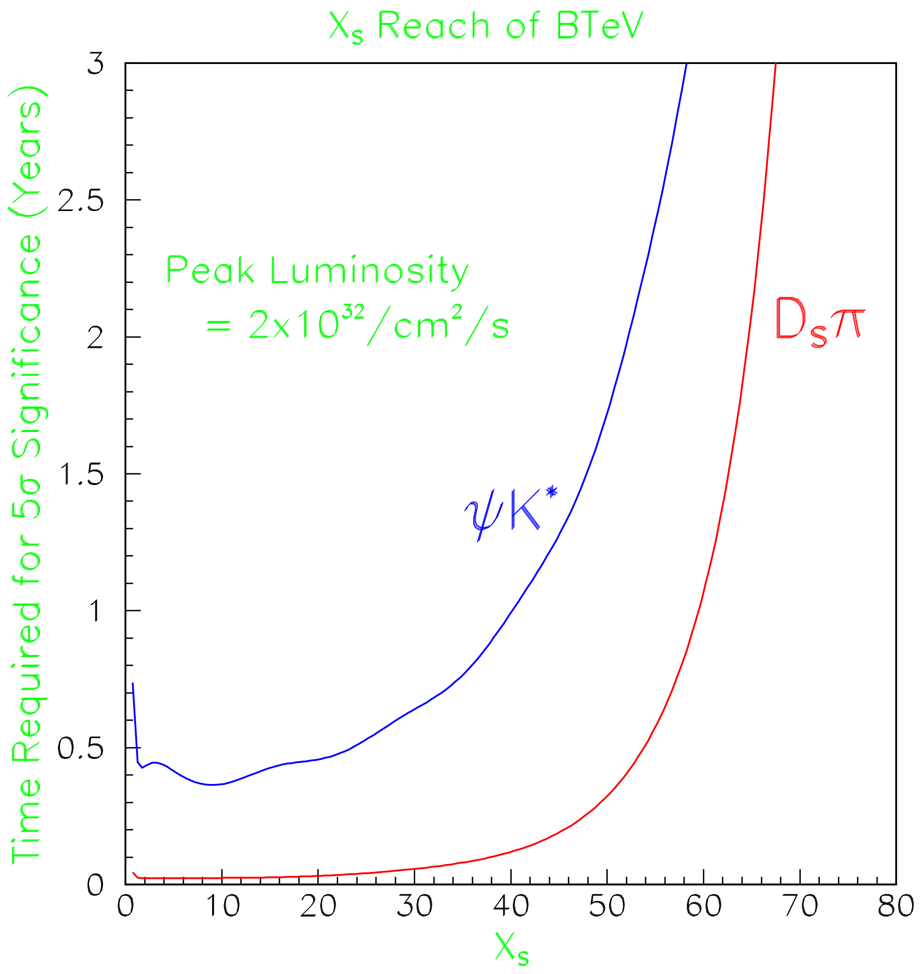
  excellent vertexing (40-60 fs resolution)

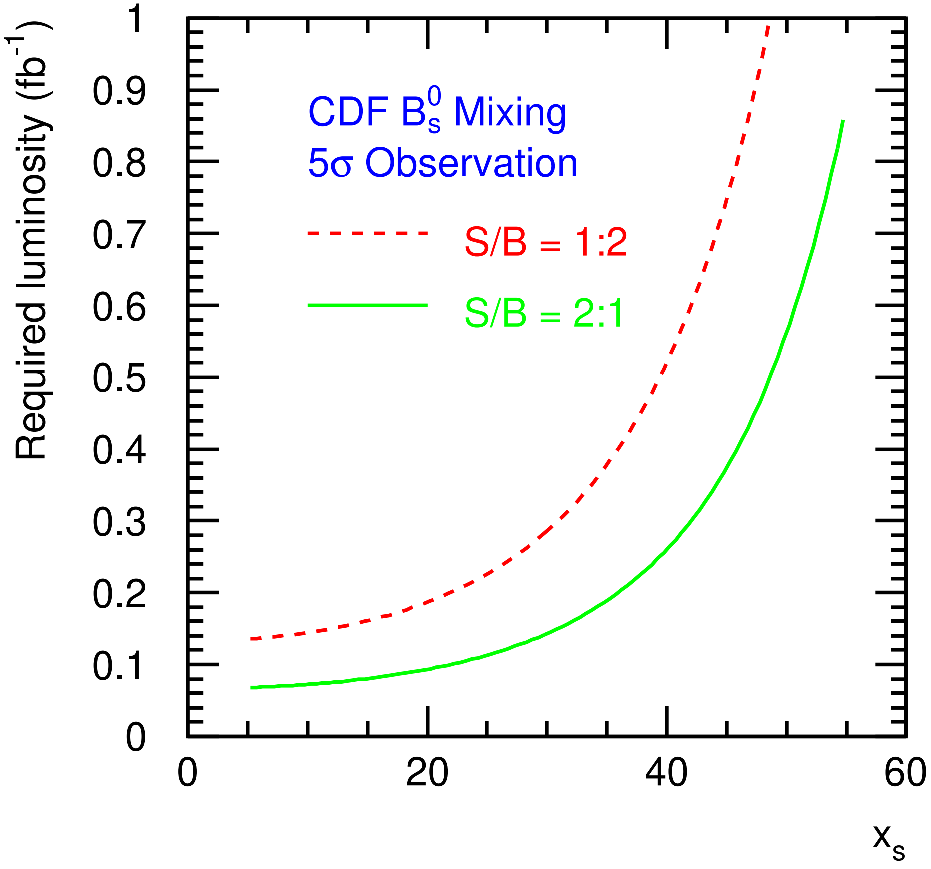
  particle identification (tagging, background)
- reach of roughly 60 (BTeV goes higher)
- measure mixing early in Run II or
- .. something wrong with Standard Model

DØ started to investigate: $B_s^0 \to J/\psi K^{*0}$

- first results look promising

x_s Reach in Hadronic Modes





BTeV analysis very conservative
excellent sensitivity

CDF analysis more detailed
use data/experience from Run I

B_s^0 Mixing Semileptonic Decays

Study from CDF:

☞ special trigger: lepton and SVT track

☞ sample size roughly 40k events

☞ $\nu\ell^+ D_s^-$: $\nu\ell^+ D_s^{*-}$ = 2 : 5

☞ vertex resolution $\approx 60\,fs$

☞ momentum correction according to MC

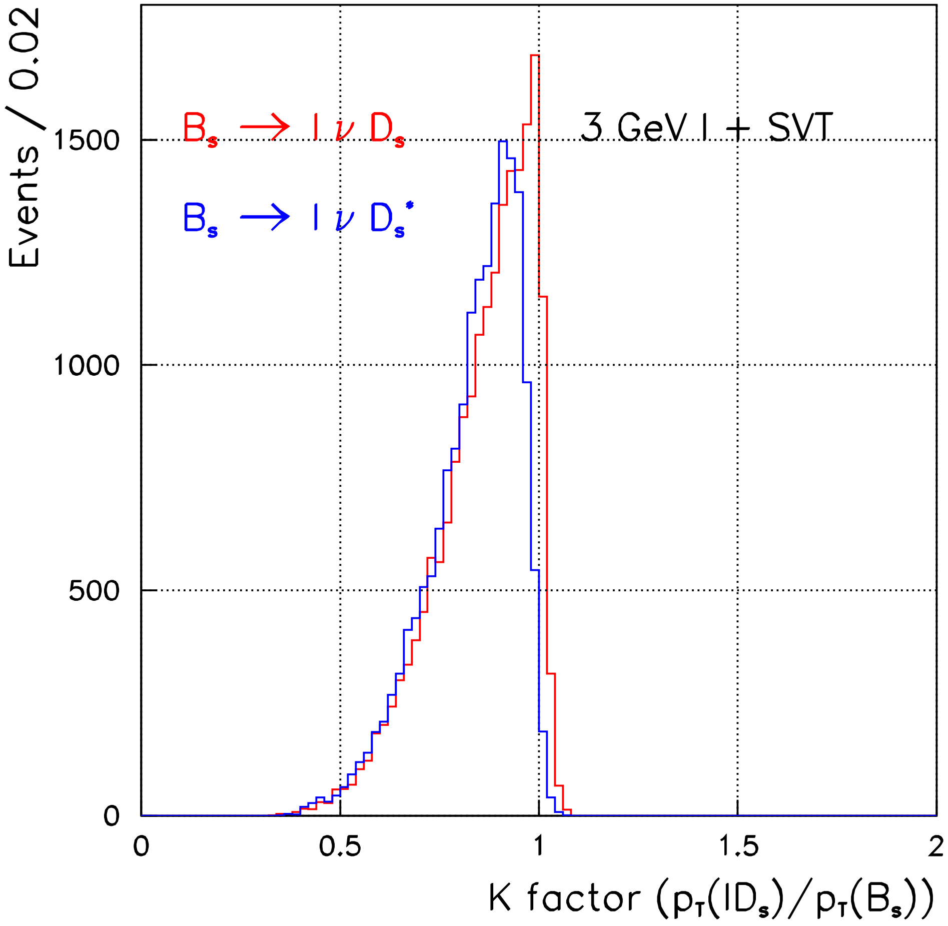
☞ 3d vertex correction

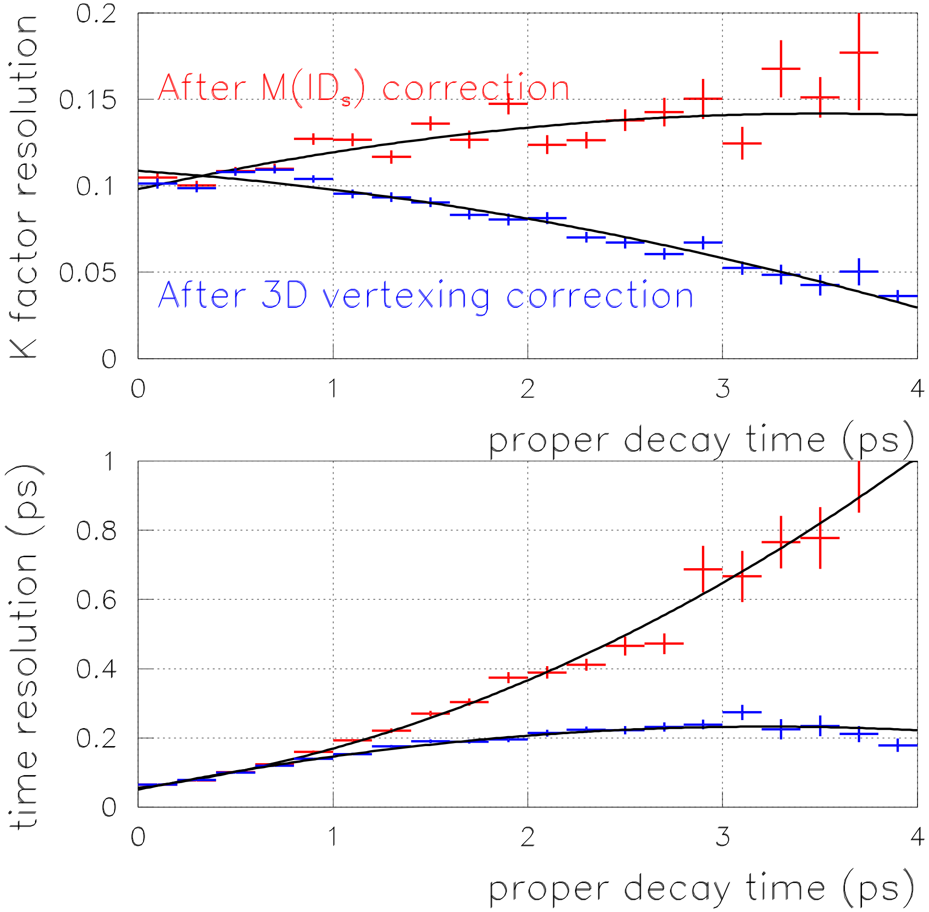
Result:

☞ measurement feasable up to $x_s = 30$

☞ inferior to hadronic modes

x_s Proper Decay Time





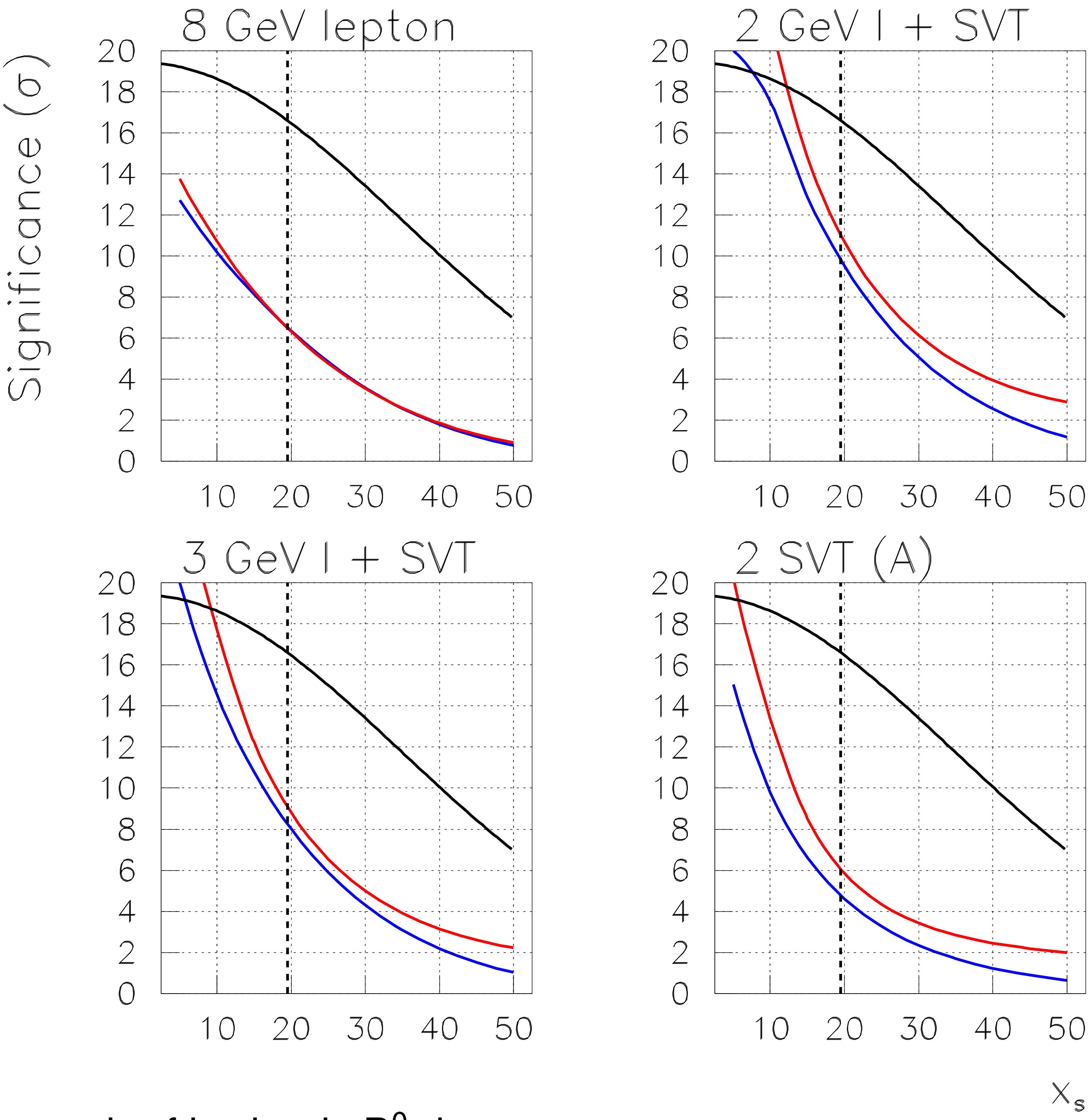
correct for missing momentum

careful: CDF also looses γ from D_s^{*-}

3d direction of B constraint

darn: helps only in low ct region

x_s Reach Semileptonic B_s^0 Decays



reach of hadronic B_s^0 decays

including 3d vertex correction

without 3d vertex correction

$\Delta\Gamma_{B_s^0}$ Measurement

Studies from BTeV and CDF:

- measure $\Delta\Gamma_{B_s^0}$ in mixing distribution
- fit two exponentials to lifetime distribution
- use two samples and/or angular analysis

CDF extrapolations from Run I:

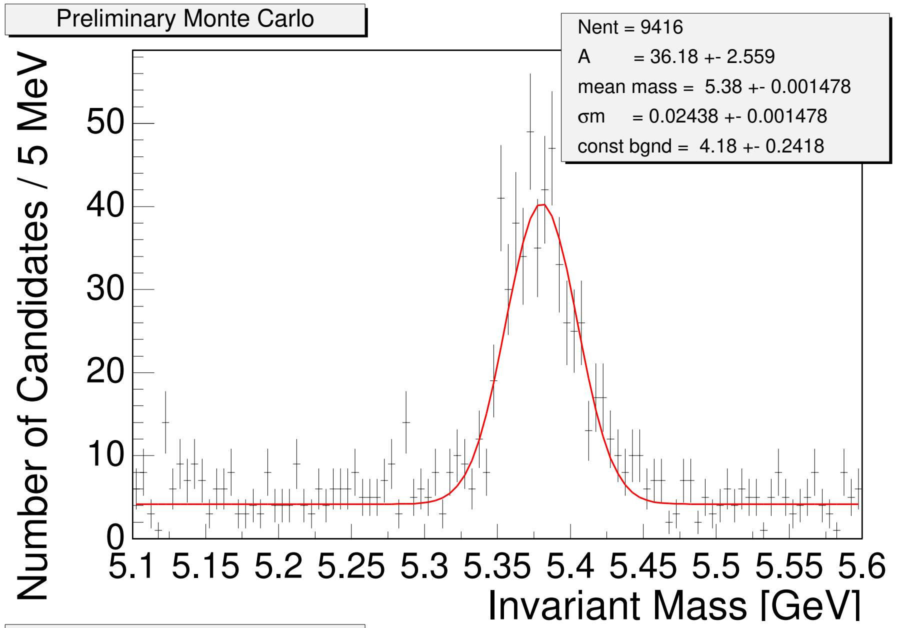
- mixed sample (H=0.5, L=0.5): $B_s^0 \to D_s^- \pi^+$
- “more” CP even sample: $B_s^0 \to J/\psi\phi$
- from Run I: $\Gamma_\perp/\Gamma_S = 0.229 \pm 0.188 \pm 0.038$
- refine angular analysis (see Dighe talk)
- projected error: $\sigma(\Delta\Gamma_{B_s^0}/\Gamma_{B_s^0}) = 0.065$ (2 fb^{-1})
- refinements needed

BTeV first Monte Carlo studies (MCFast):

- measuring CP odd/even and mixed modes
- two decay modes: $B_s^0 \to J/\psi\phi$ and $B_s^0 \to D_s^- \pi^+$
- projected error: $\sigma(\Delta\Gamma_{B_s^0}/\Gamma_{B_s^0}) = 0.02$ (2 fb^{-1})
- refine angular analysis

Summarizing: For writeup some work needed!!

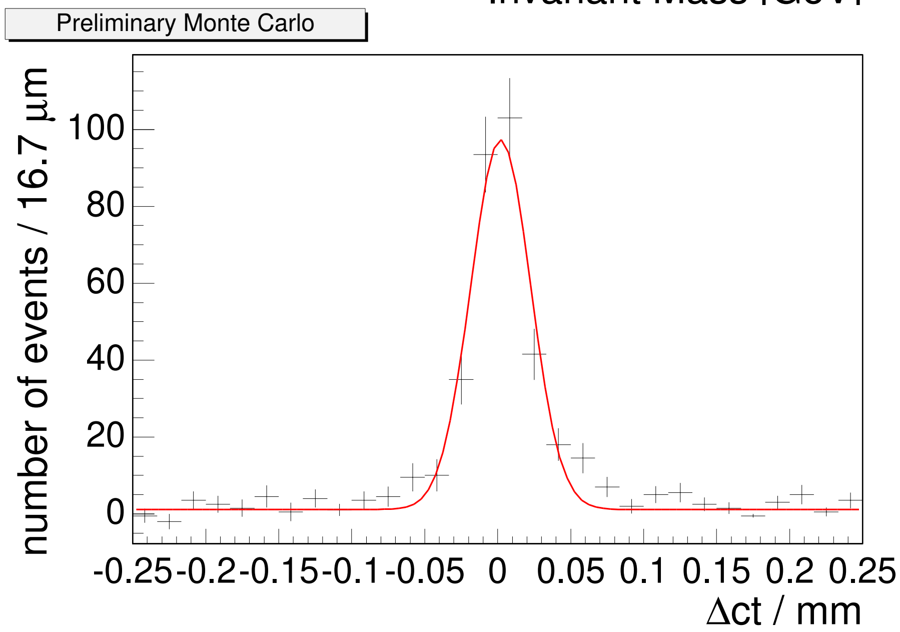
GEANT Simulation Effort (CDF)



reconstruction of $B_s^0 \rightarrow D_s^- \pi^+$

complete vertex fit applied

expected mass resolution: $\approx$ 25 MeV



χ^2 fit yields ct resolution of $(20 \pm 1)\mu m$

agrees with expectation: $18\mu m$

further cross checks going on

Organization

Procedure defined:

☞ write up under responsibility of conveners

☞ involve people which do the analysis

Rough outline prepared:

☞ three sections:

Lifetimes, $\Delta\Gamma_{B_s^0}$, B_s^0 Mixing

Conclusions

Topics covered in this Workshop:

- ☞ B_s^0 mixing: hadronic modes (BTeV, CDF)
- ☞ new: Λ_b^0 lifetime analysis (DØ)
- ☞ new: B_s^0 mixing: $B_s^0 \rightarrow J/\psi K^{*0}$ (DØ)
- ☞ new: B_s^0 mixing: semileptonic modes (CDF)
- ☞ new: $\Delta\Gamma_{B_s^0}$ with several methods (BTeV, CDF)

Quite some new information since first meeting

Follow up:

- ☞ new analyses need to polished
- ☞ CDF, DØ use opportunity to develop tools
- ☞ meanwhile reports will be written
- ☞ update of report with best analyses continues