B Physics Analyses for Moriond

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D0 Collaboration Meeting
02/14/03

On the road to Moriond

- The *'Moriond'* data sample:
  - Sep.24, 2002 – Jan 9. 2003
  - p13.04.00, p13.05.00
  - thumbnails skimmed using np_tmbstream_package
    - Filter events that passed a muon trigger (list used)
    - Di-muon skim & single-muon skim
  - root-trees made using TMB_Analyze_x
    - *Vivek Jain, Xiaojian Zhang*
  - 10 datasets in total (~50 pb^{-1})
  - J/ψ analyses use root-tuples created from these root-trees using *A.Schwartzman's* 'd0root_analysis' & 'd0root_btag' packages

www-d0.fnal.gov/Run2Physics/ckm/d0_private/computing/data_files_onDISK.html

On the road to Moriond

- The re-processed *'Moriond'* data sample:
  - Di-muon sample re-processed with AATrack algorithm (with extended cuts)
  - Higher sensitivity of AATrack to low momentum tracks (0.18 Gev)
    - Increase reconstruction efficiency for exclusive B-hadron decays
    - Increase the output of K_s and Λ
  - Pre-selection criteria (output of default GtrHtf):
    - Require 2 tracks with muon id to be in the (2.0-4.0) GeV mass window
  - ~ 355k events have been re-processed (~ 91% of the 10 set sample)
  - Details in G.Borrisov's plenary talk

A *B factory* at the Tevatron

$\sigma(p\bar{p} \to b\bar{b}) = 150\ \mu b\ @2\ TeV$

$\sigma(e^+e^- \to Z^0 \to b\bar{b}) = 7\ nb$

$\sigma(e^+e^- \to \Upsilon(4S) \to b\bar{b}) = 1\ nb$

Large production cross-section

All species, including B_s, B_c, Λ_b,

DØ B Physics Program:

- B Lifetimes
  - Average B lifetime: $B \to J/\psi\ X$
  - Λ_b lifetime: $\Lambda_b \to J/\psi\ \Lambda$
  - B_s lifetime and width: $B_s \to J/\psi\ \phi$
- CP violation ($\sin 2\beta$): $B \to J/\psi\ K_s$
- Rare decays, cross-sections, spectroscopy measurements…

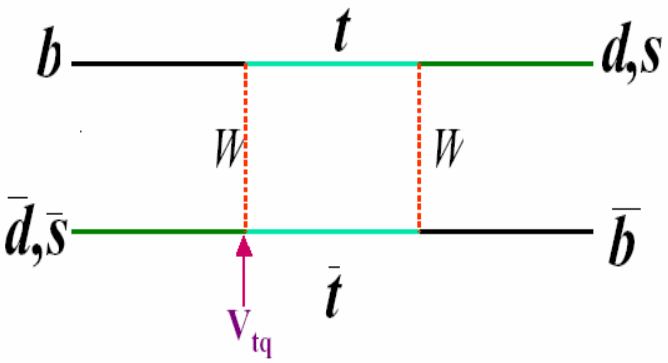
But the greatest <u>impact</u> can be made by a measurement of --

B_S mixing

- B_S mixing is one of the high priority items on the DØ B physics program
  - Weak eigenstates ≠ mass eigenstates
  - Mixing due to higher order corrections

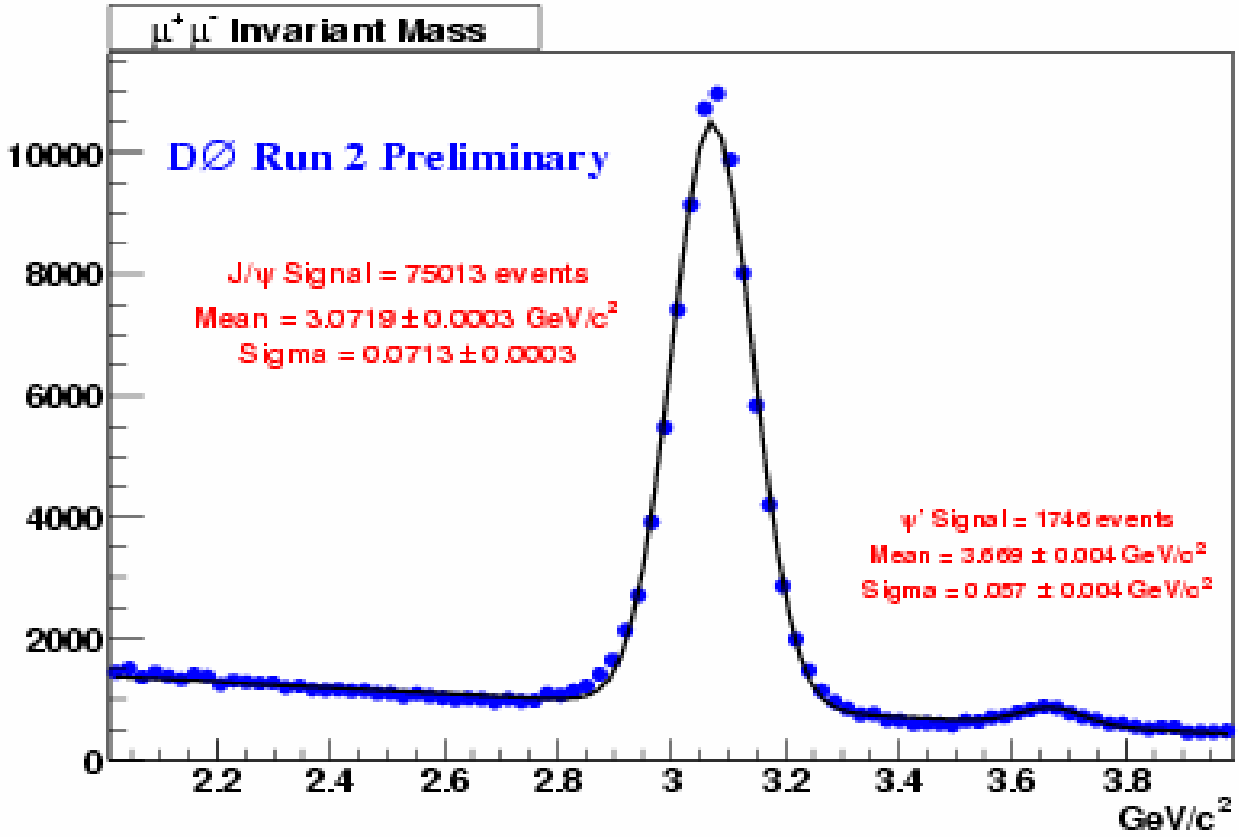
    $\Delta m_s = m(B^o_{heavy}) - m(B^o_{light})$

    $\Delta m_s \propto |V_{tb}V_{ts}|^2$
  - Mixing parameters: $x_s = \Delta m_s/\Gamma_s$ and $\Delta\Gamma_s$



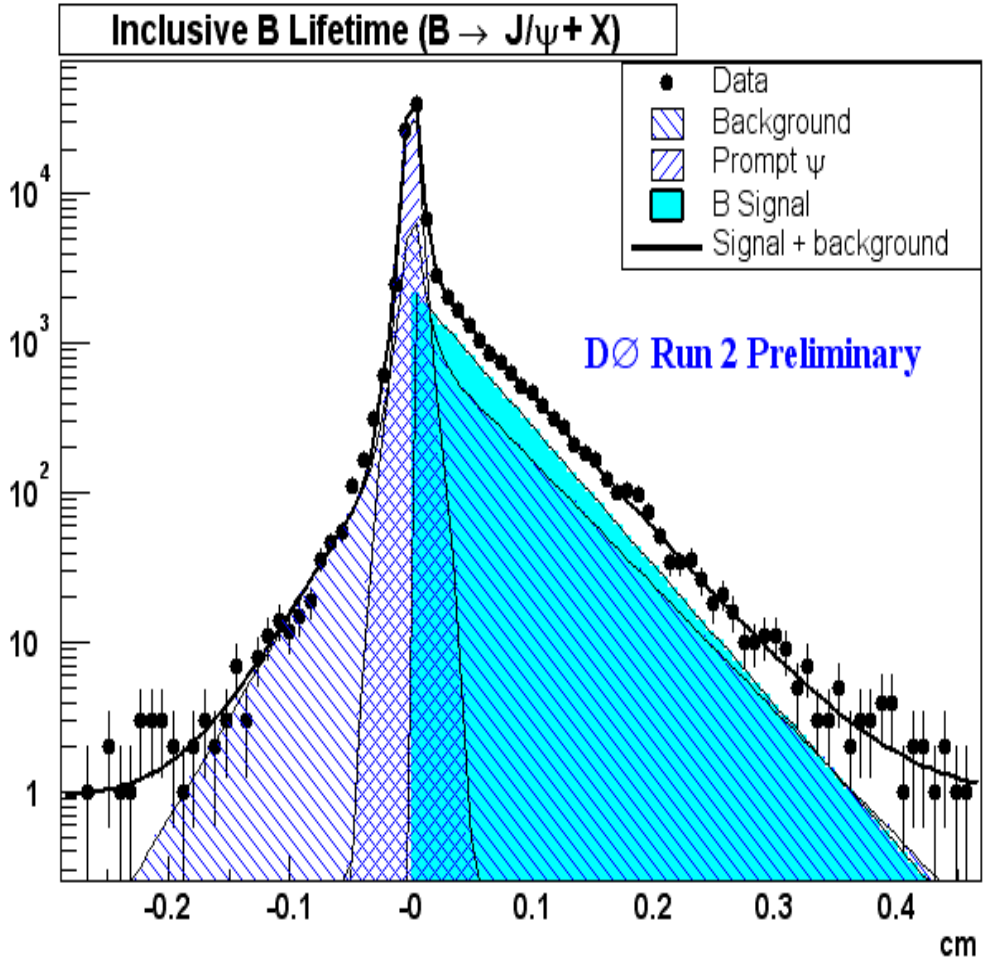
- A typical oscillation analysis involves:
  - Proper time reconstruction for each meson candidate
  - Selection of final states suitable for the study
    - Tagging of the meson flavor at decay time
    - Tagging of the meson flavor at production time

$J/\psi \rightarrow \mu^+\mu^-$



Eduard Burelo

Inclusive B Lifetime



$B \rightarrow J/\psi + X$

$\hookrightarrow \mu^+\mu^-$

Cuts:

1. $p_T(\mu) > 1.5$ GeV
2. SMT hits > 3
3. CFT hits > 4
4. $p_T(J/\psi) > 3$ GeV

Fraction of prompt J/ψ =82%
Fraction of outlyers = 1×10^{-3}

PDG: $\langle\tau\rangle = 1.564 \pm 0.014$ ps

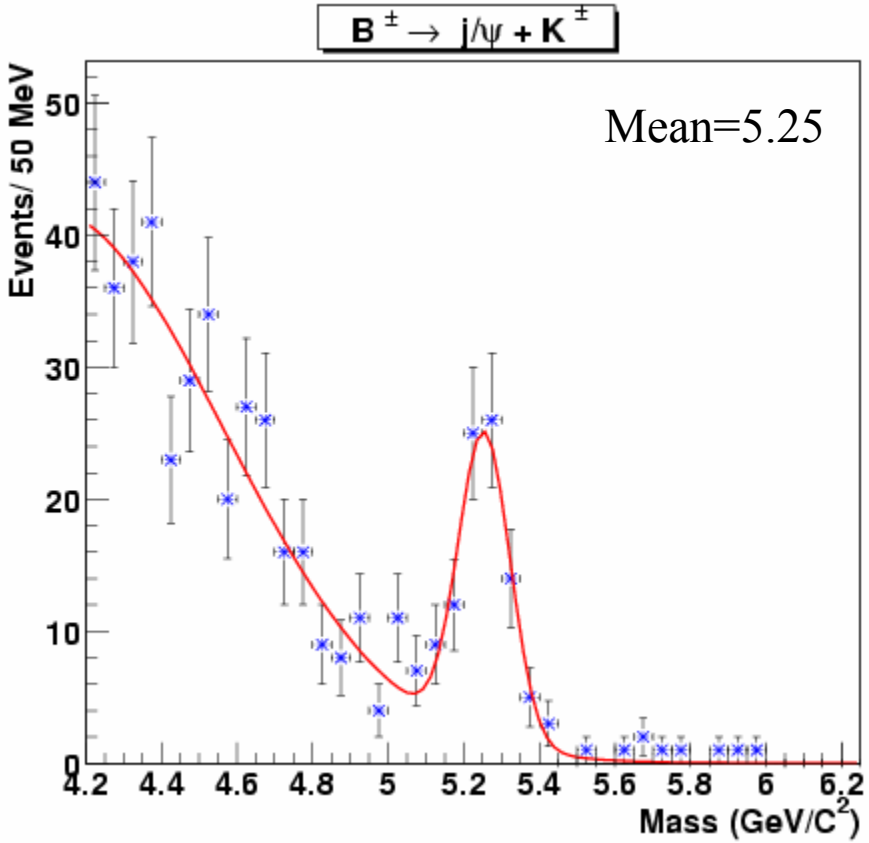
Eduard Burelo

(~ 41 pb^{-1})

$$\langle \tau \rangle = 1.553 \pm 0.023 \text{ (stat)} \; {}^{+0.043}_{-0.11} \text{ (sys)} \text{ ps}$$

B^+ Mass

$B^+ \rightarrow J/\psi\ K^+$ Imp. calibration sample for flavor tagging studies



Cuts (J/ψ):

1. Muons with opp. Charge
2. $p_T(\mu) > 2.0$ GeV
3. SMT hits ≥ 4
4. χ^2 on J/ψ vertex < 10
5. $2.9 < J/\psi$ mass < 3.2

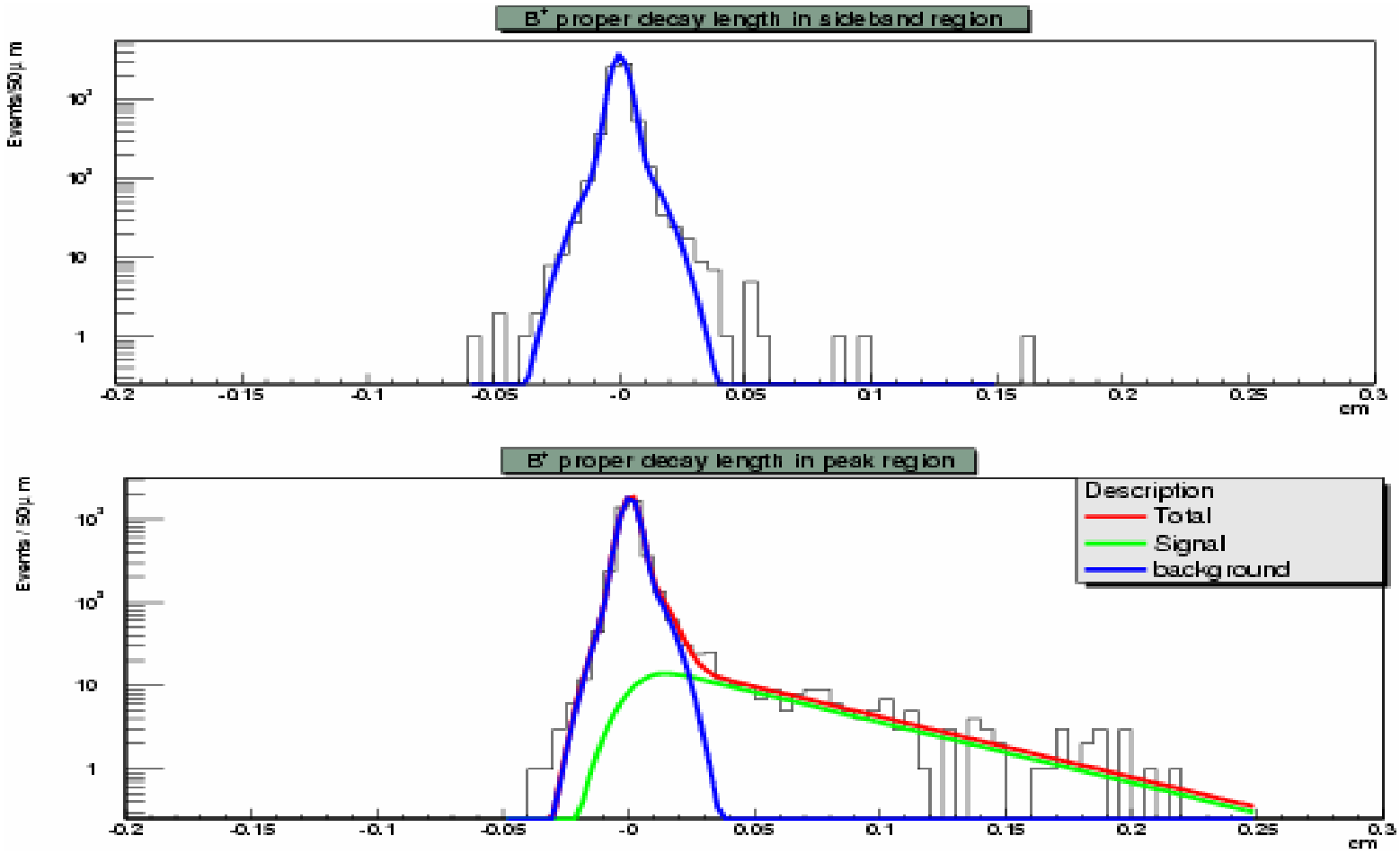
Cuts (B^+):

1. χ^2 for K < 10
2. Total $\chi^2 < 20$
3. Kaon hits ≥ 3
4. $p_T(K) > 1.5$ GeV

($\sim 41\ pb^{-1}$)

P.Podesta

B^+ Lifetime



PDG: $\tau = 1.674 \pm 0.018$ ps

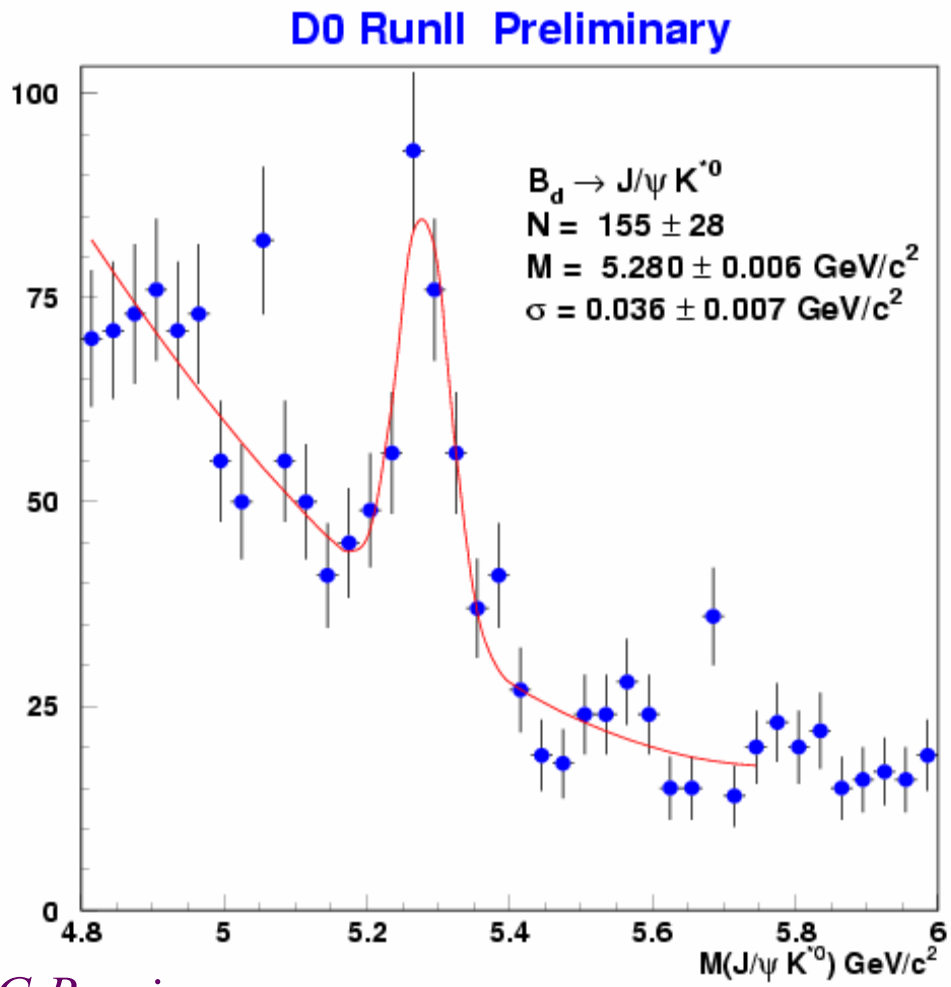
(~ 41 pb^{-1})

Signal region: 4.964-5.494 GeV ; Sideband region: 5.760-6.583 GeV

P.Podesta

$\tau = 1.995 \pm 0.31(stat)$ ps

$B_d \rightarrow J/\psi K^*$



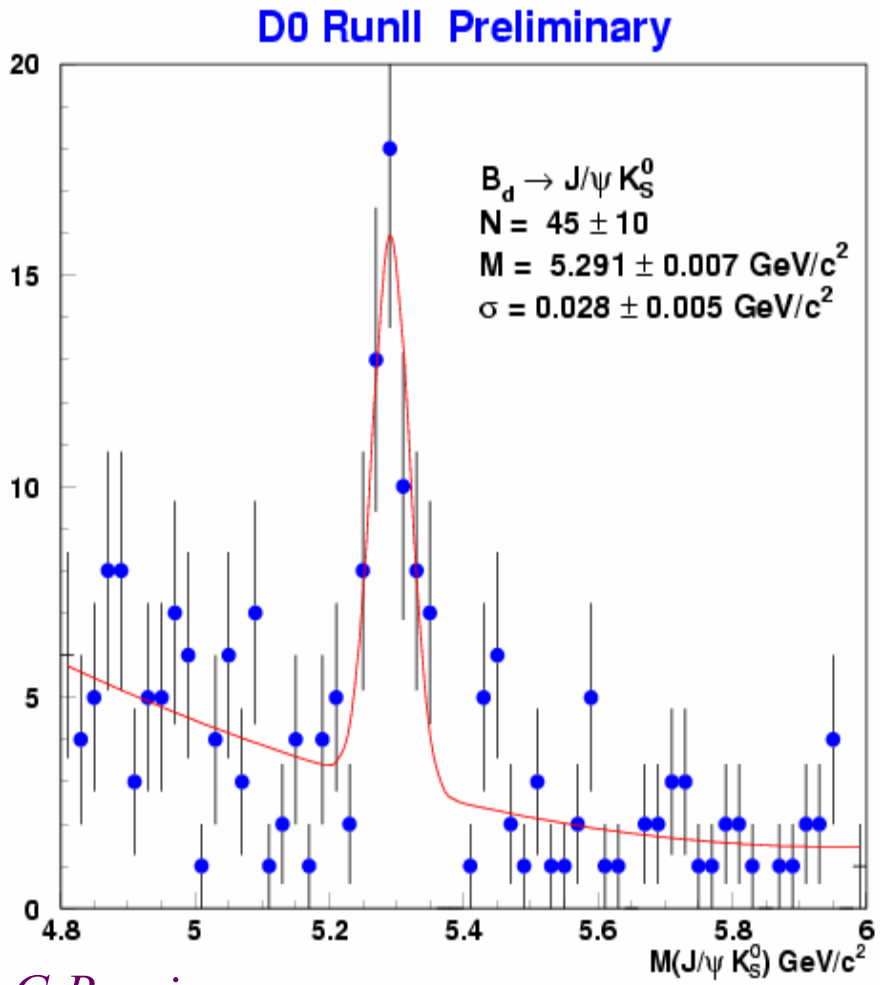
G.Borrisov

Cuts (J/ψ):

1. Muons with opp. charge
2. $p_T(\mu) > 1.5$ GeV
3. SMT hits ≥ 1
4. CFT hits ≥ 1
5. $p_T(J/\psi) > 4.0$ GeV

Datasets reprocessed with AA tracking (~42 pb^{-1})

$B_d \rightarrow J/\psi K_s$



G.Borrisov

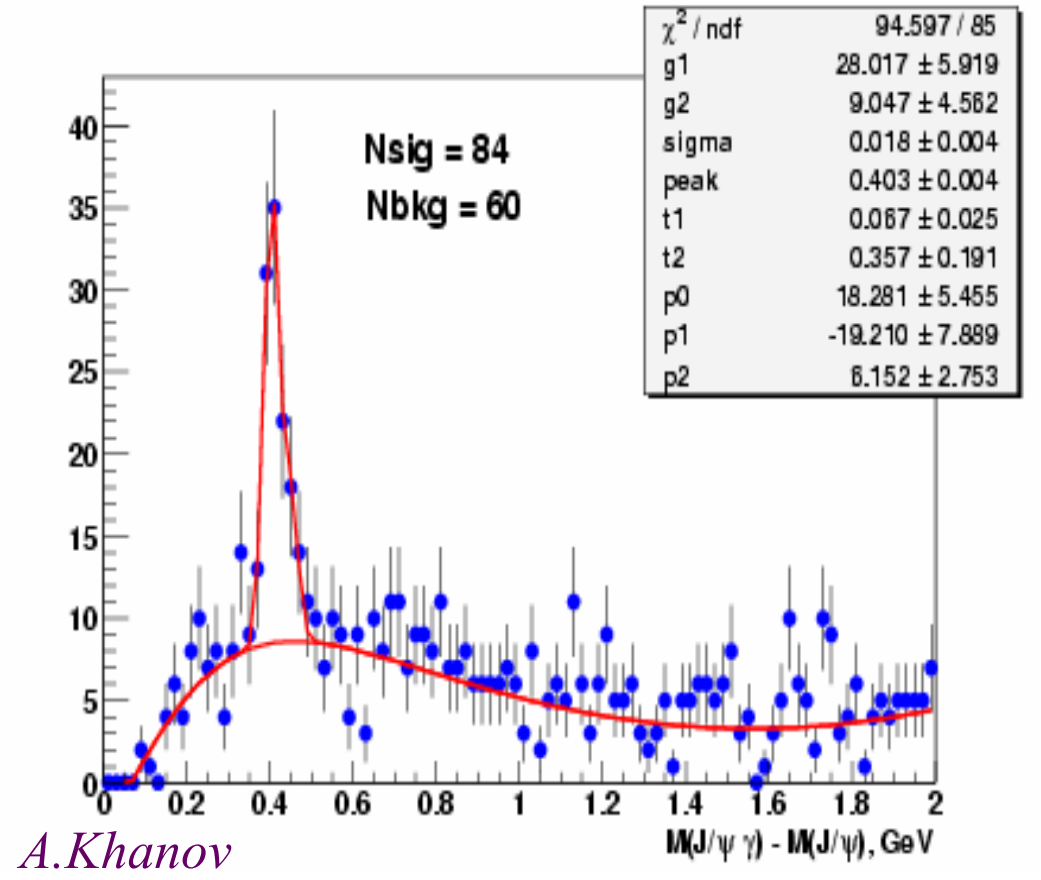
Decay mode for
CP violation (sin2β)

Cuts:

1. $2.9 < M(\mu\mu) < 3.25$
2. SMT hits ≥ 2
3. 3 particle vertex with $\chi^2 < 25$
4. $p_T(K_s) > 0.5$ GeV

Datasets reprocessed
with AA tracking (~42 pb^{-1})

$\chi_c \rightarrow J/\psi\,\gamma$



A.Khanov

J/ψ production puzzle:
Why the J/ψ yield is 1-2 orders of magnitude higher than predicted by theory ?

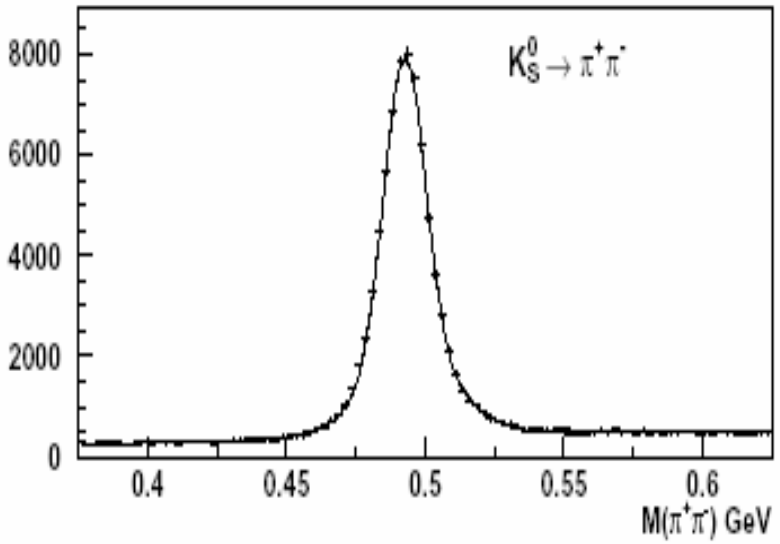
Cuts:

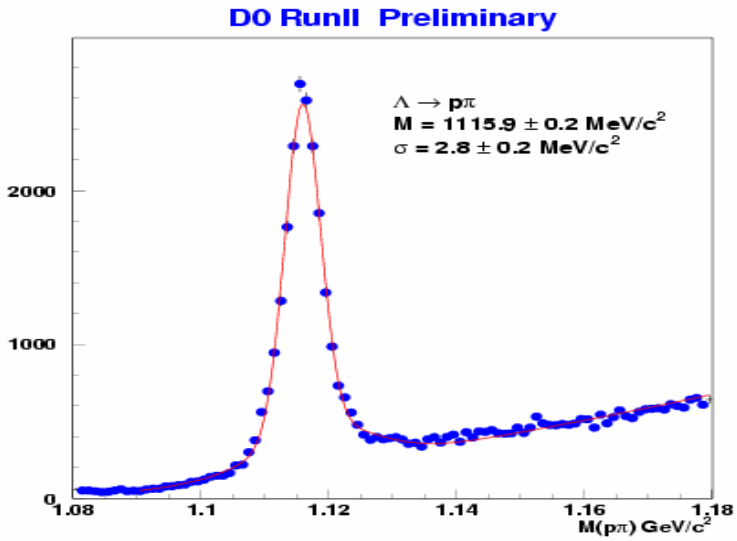
1. $p_T(\mu) > 2.0$ GeV
2. $p_T(\gamma) > 1.0$ GeV

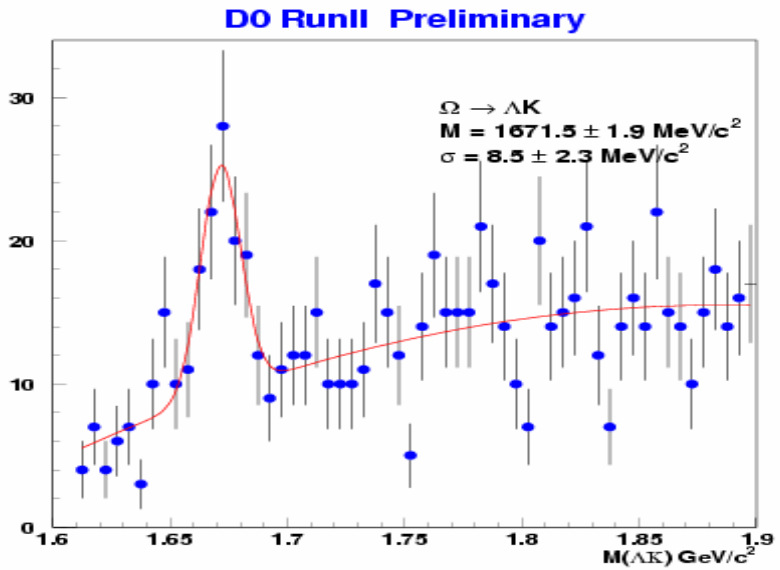
$N_{signal} = 84$, $N_{bkg} = 60$
$\Delta M = (403 \pm 4)$ MeV
$\sigma = (18 \pm 4)$ MeV

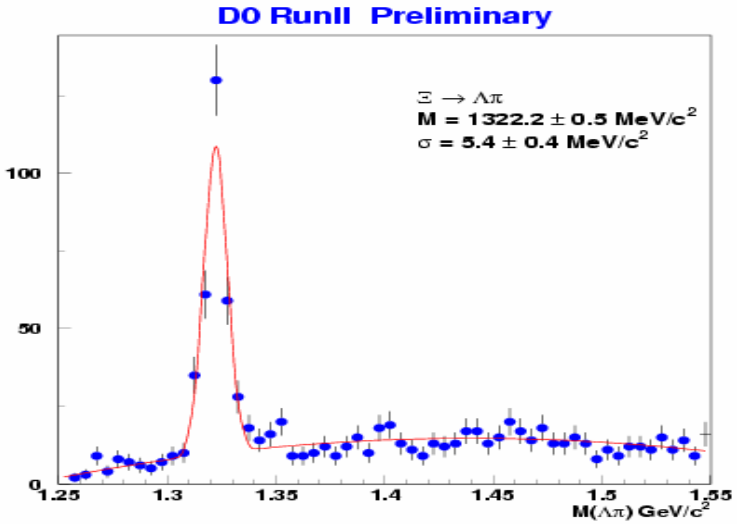
Datasets reprocessed with AA tracking (~ 42 pb^{-1})

Pretty pictures

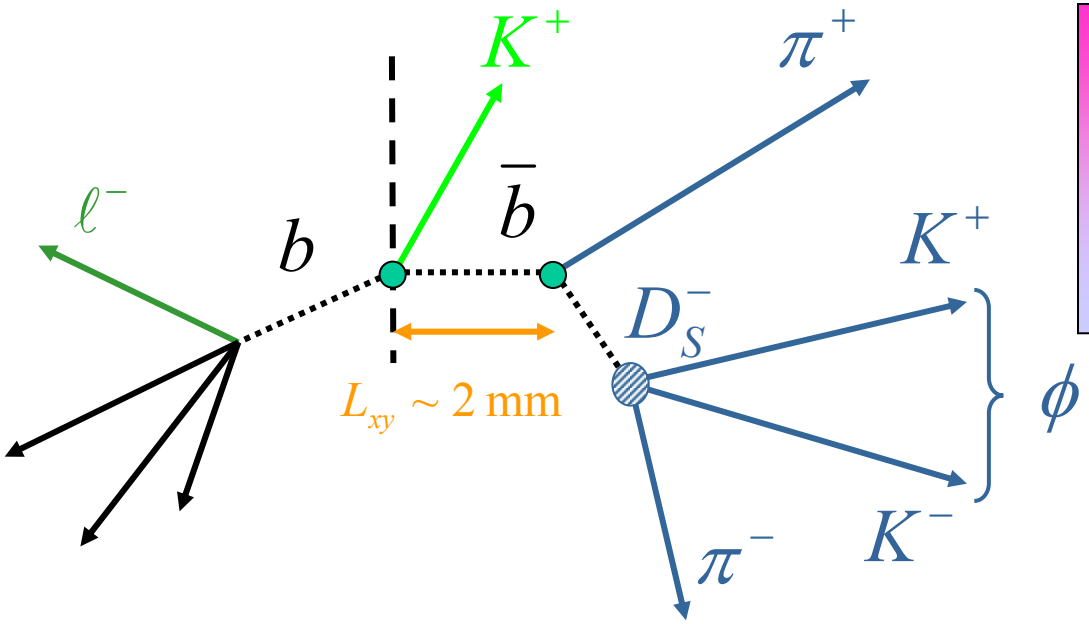








Flavor Tagging



meson flavor at production (t=0):

Opposite Side Tag:

- identify the flavor of the other *B* in the event
  - soft lepton tags $b \rightarrow l^- + X$
  - jet charge tags $Q_{jet} < 0$ for b

Same Side Tag : hadronization

Soft-muon tagging: ver0.1 ("Moriond")

Charge of highest p_T muon $\Rightarrow$ B-tag

Jet Charge Tagging:

Take the opp. direction of the reco'd B, make a ϕ cone of 1.14 and remove tracks outside this cone

Calculate the jet charge,Q

$$Q = \frac{\sum pT_i * q_i * W_i}{\sum pT_i * W_i}$$

Sign of Q $\Rightarrow$ sign of b quark that produced the jet

Soft Lepton Tagging

Soft-muon tagging: ver0.1 ("Moriond") *C.Leonidopoulos*

$B^{\pm} \rightarrow J/\psi\, K^{\pm}$ ($\sim 41\ pb^{-1}$)

	Mass window 5.15-5.45 GeV	Left Sideband 4.6-5.0 GeV	Right Sideband 5.5-6.0 GeV
# of events	188	287	48
# of correct tags	11	10	3
# of wrong tags	3	11	3

Jet Charge Tagging

Algorithm: *X. Zhang*

	Mass window 5.1-5.4 GeV	Left Sideband 3.9-4.8 GeV	Right Sideband 5.8-6.7 GeV
# of events	119	862	9
# of correct tags	42	249	3
# of wrong tags	22	210	2

Datasets reprocessed
with AA tracking (~ 42 pb^{-1})

b jet production cross-section

- Strategy: (Onne Peters)
  - Measure μ+jet cross-section
  - Extract b-content using P_T^{Rel}
- Data selection & kinematic cuts

  mu1ptxatxx_CJT5 trigger

  $p_T^{\mu} > 6$ GeV/c, $|\eta^{\mu}| < 0.8$

  Track measured in muon system only

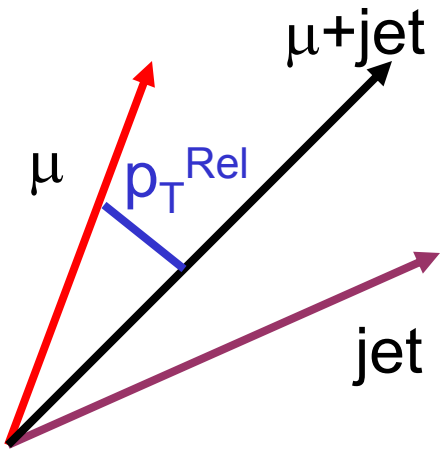
  A layer segment + BC layer segment

  Converged fit between segments

  $|\eta^{jet}| < 0.6$, $E_t^{corr} > 20$ GeV

  0.5 cone

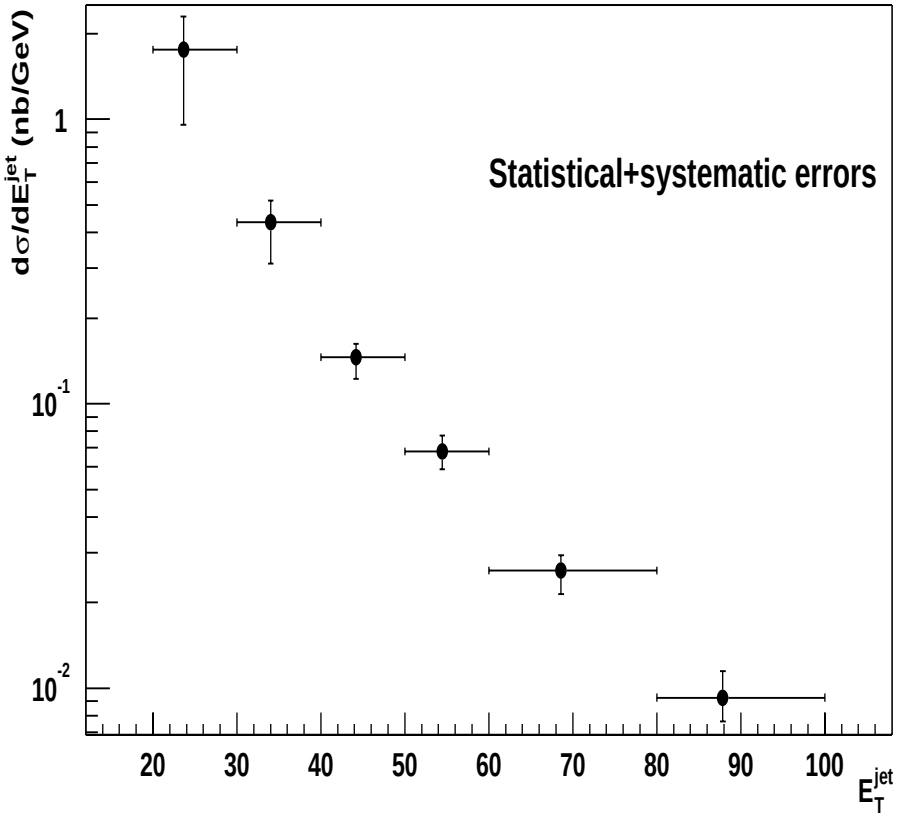
  $\delta R(jet,\mu) < 0.7$



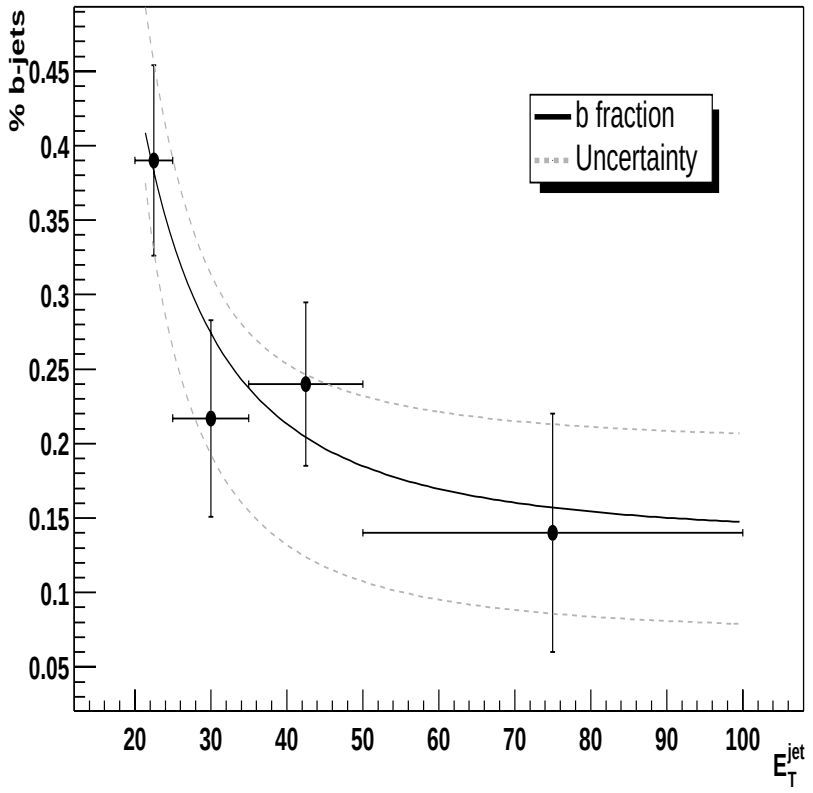
Data:
02/28/02-05/10/02 :
(3.4 pb^{-1})

The 'beauty' content

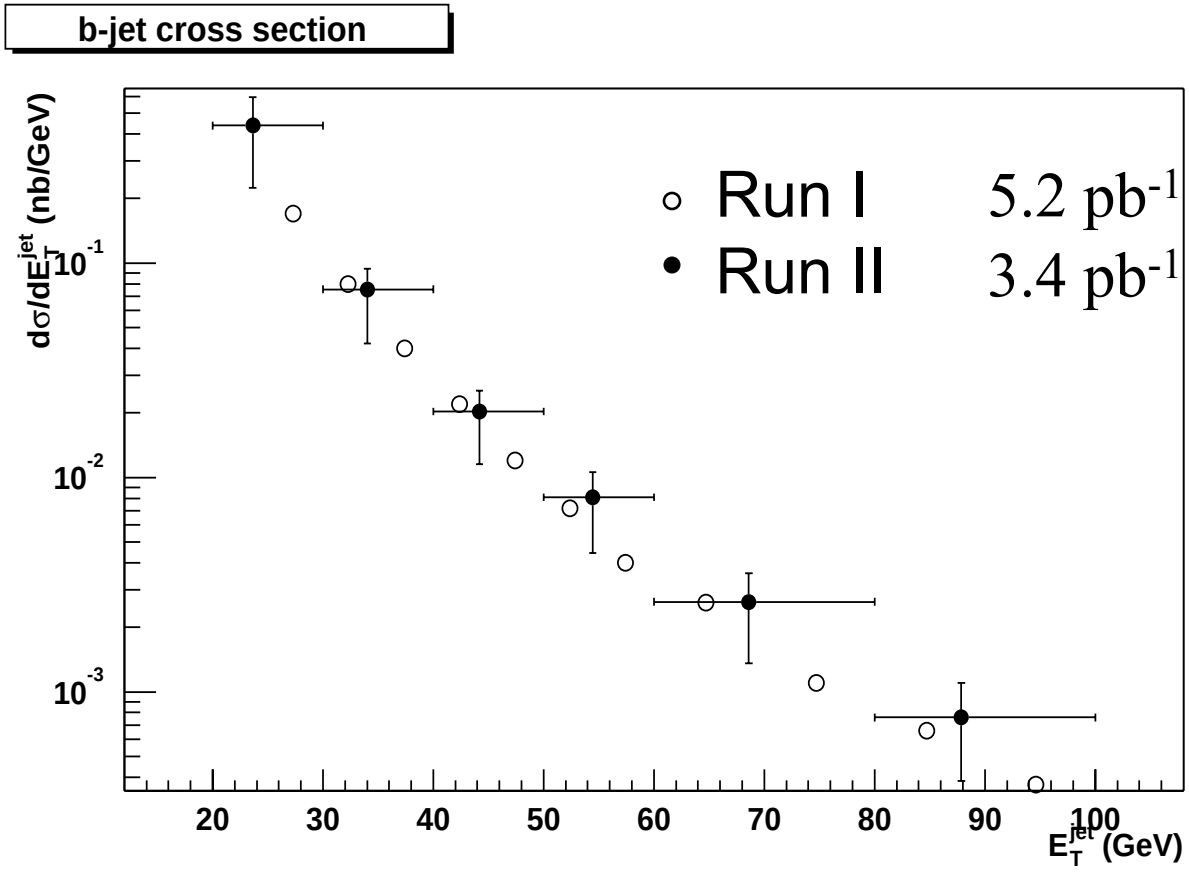
Muon+Jet Crosssection, sys+stat errors



B-jet content



b-jet cross-section



Unsmeared for detector resolution effects

Summary

- Lots of progress since last year:
  - Inclusive B lifetime
  - B^+ lifetime
  - Reconstruction of exclusive B final states
  - Study of charmonium states
  - Development of tagging algorithms
  - *b*-jet production cross-section
- This is just the beginning – lots more to come…