CP violation parameters in Bs → J/ψφ analysis at CDF experiments

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Result for B_s to J/Psi Phi at CDF

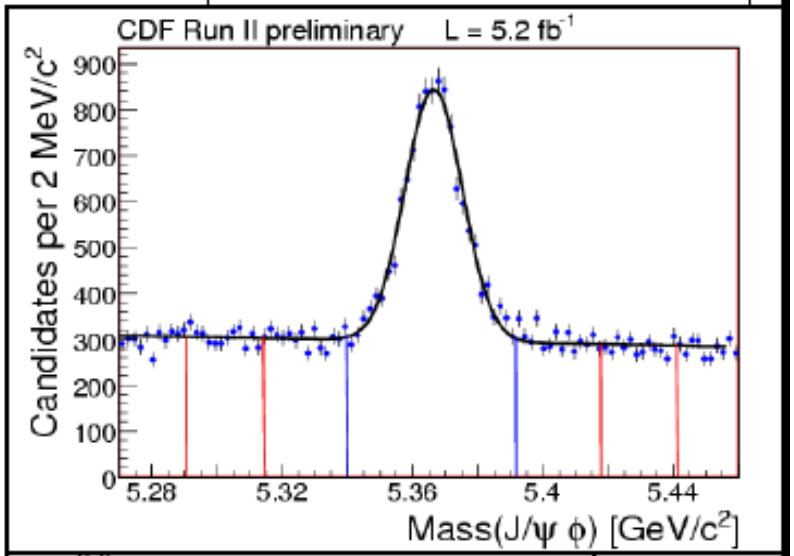
$B_s \rightarrow J/\psi\,\varphi$ (CDF)

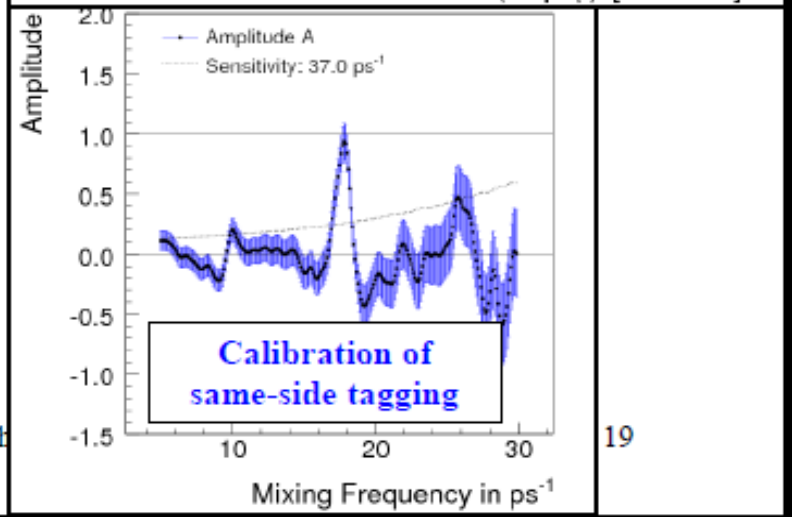
G. Giurgiu, ICHEP-2010,
CDF Public note 10206

- 5.2 fb^{-1} of data analyzed
- ~6500 signal events
- Same side flavour tagging calibrated in data
- Strong phases are free
- S wave included in the fit
  < 6.5% at 95% CL

$$\tau_s = 1.529 \pm 0.025\ (\text{stat}) \pm 0.012\ (\text{syst})\ \text{ps}$$
$$\Delta\Gamma_s = 0.075 \pm 0.035\ (\text{stat}) \pm 0.01\ (\text{syst})\ \text{ps}^{-1}$$

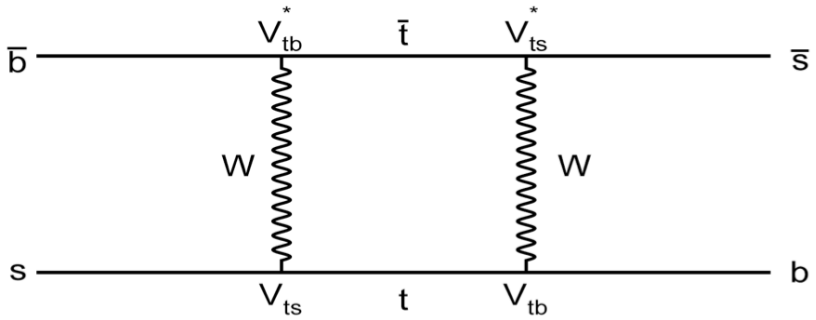
Most precise measurements of $\tau(B_s)$ and $\Delta\Gamma_s$



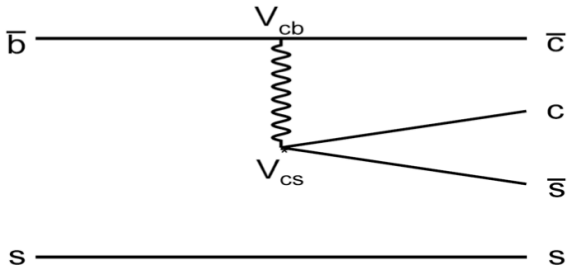


2010/07/27 BSM searches through B ph 19

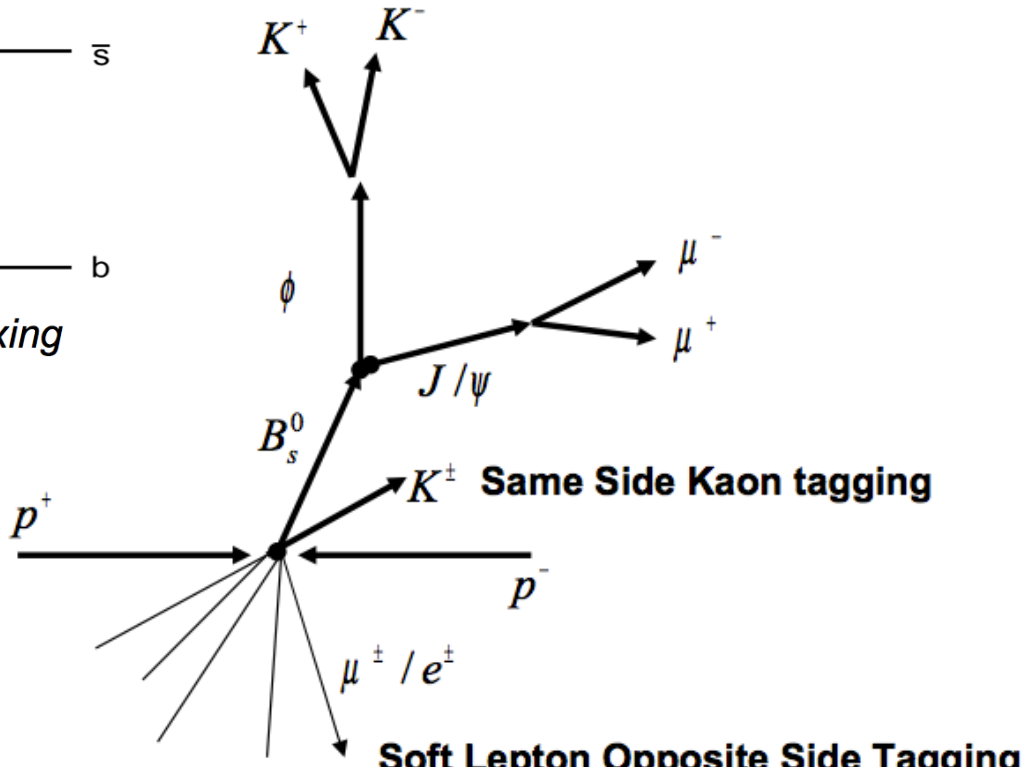
Analysis : B_s to J/Psi Phi



Feynman box diagram for the B_s mixing



Feynman diagram for the $B_s \to J/\psi\,\phi$



Kinematics of an event

Measurement of β_s and $\Delta\Gamma$

Method of Analysis

1) Reconstruction of the Bs→J/ψ ϕ mode
   - Kinematic recontruction of the final state
   - Identification of the Bs flavour (b-tagging)

1) Unbinned maximum likelihood fit for the determination of the βs, ΔΓ

$$L = \prod_{i=0\ldots N} \left(f_s P(S) + (1 - f_s) P(B) \right)$$

Unbinned likelihood function: generic formulation

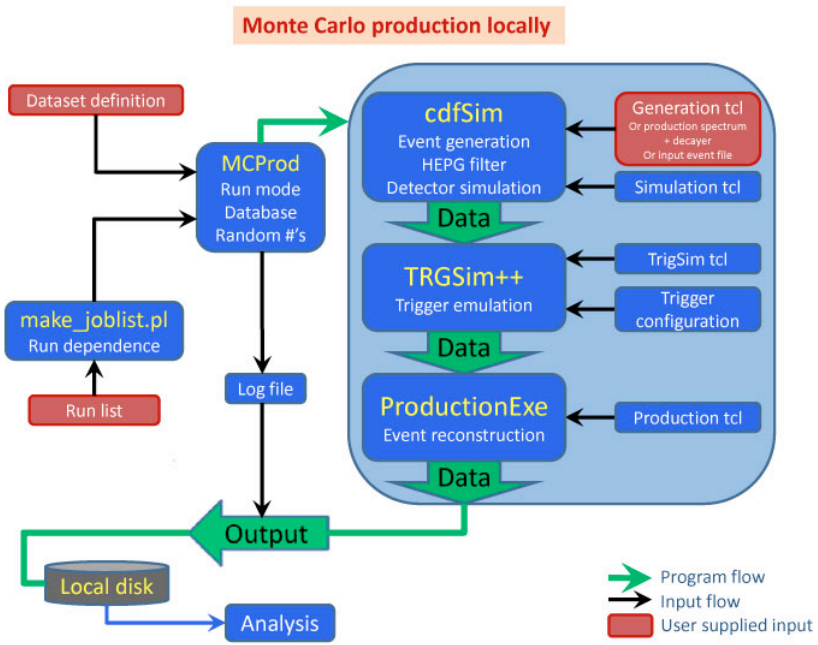
$$L = f_s \overbrace{P(m \mid S)}^{\text{Mass term}} \overbrace{P(ct, \vartheta, \psi, \phi \mid \sigma_{ct}, S)}^{\text{CP angular analysis}} \overbrace{P(\sigma_{ct})}^{\text{ct error}} + (1 - f_s) \underbrace{P(m \mid B)}_{\text{mass term}} \underbrace{P(\vartheta, \psi, \phi \mid B)}_{\text{Angular distribution}} \underbrace{P(ct \mid \sigma_{ct}) P(\sigma_{ct})}_{\text{Decay}}$$

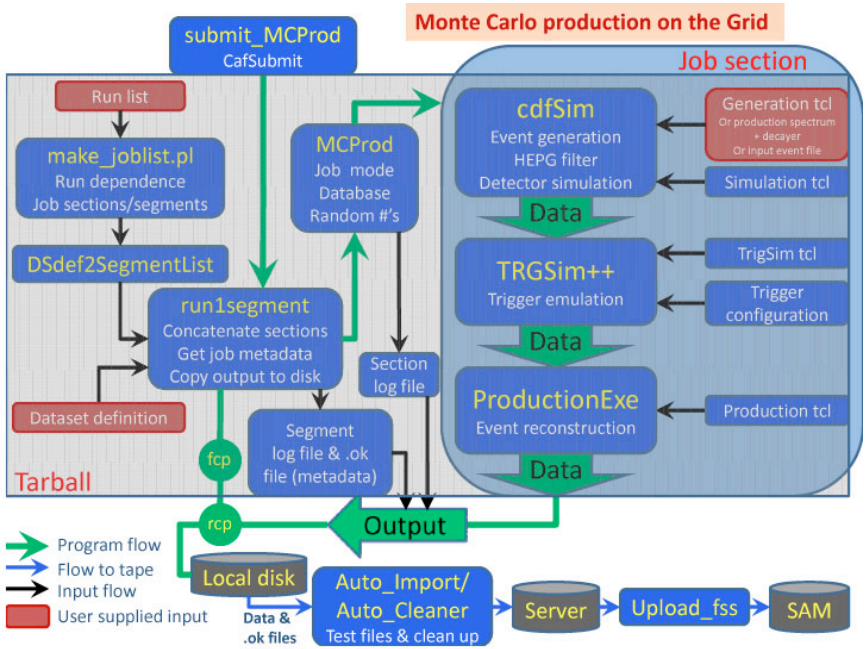
1) Mass term:
   - Signal: 1 gaussian
   - Background: 1 exponentia
2) CP angular analysis and angular distributions
3) Ct error: 2 Gamma functions
4) Background Ct distribution:
   - 1 smeared and shifted exponential (TTT)
   - 1 prompt gaussian + 2 exponential (di-muon)

To produce B-Standard Ntuple

1. MC events generation with Two Track Trigger environments.

- Bs to J/Psi Phi decay table
- apply Two Track Trigger information to Cuts
- result : *.root and *.output files
- tested by Locally and Grid server





B-Standard Ntuple

1. MC Production

#Setup environment
MCProd_v6_1_4mc_t_strip_maxopt (latest patched-t version)

The produced output file. (from gensim + trgsim + production)

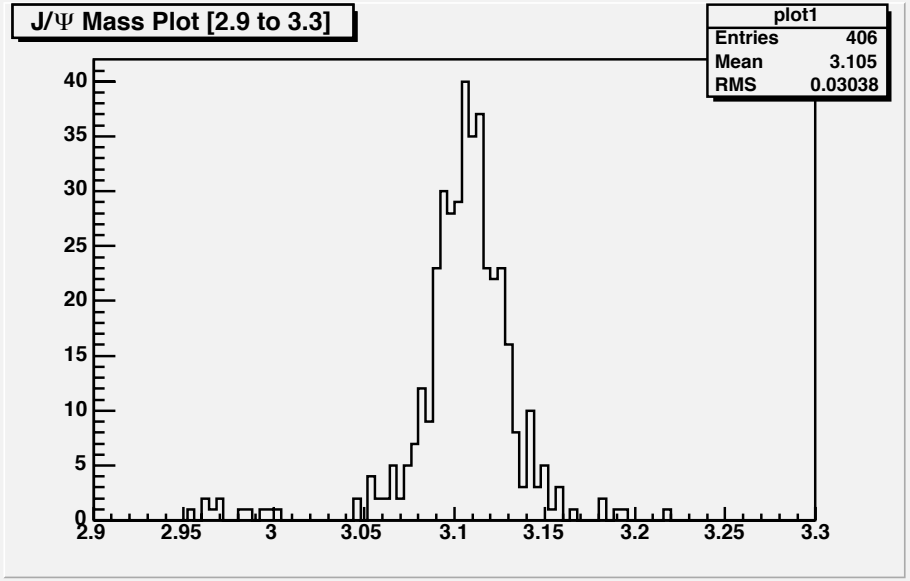
FILTER_TCL bmc_postgen_svtfilter.tcl
-> Require TTT on generator level quantities
This script applies below cuts,
- 2 tracks, |eta| < 1.3
- Pair: OppQ, sumPt > 5.0, 0.02 < dPh
PREREQ_TRIG_TCL bmc_prereq_bcharm.tcl
-> To select two-track trigger events based on level-2 bits.

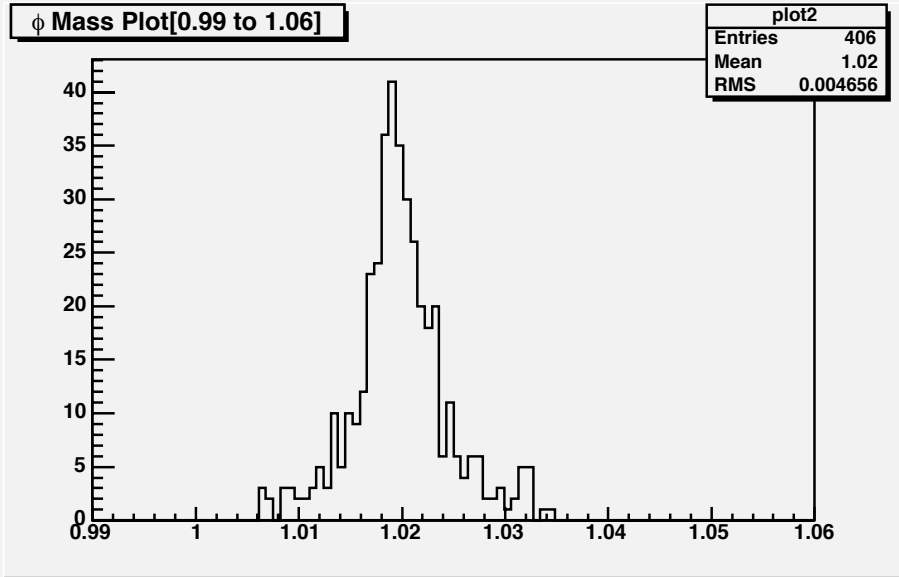
2. Make B-Standard Ntuple file using MC generation output file

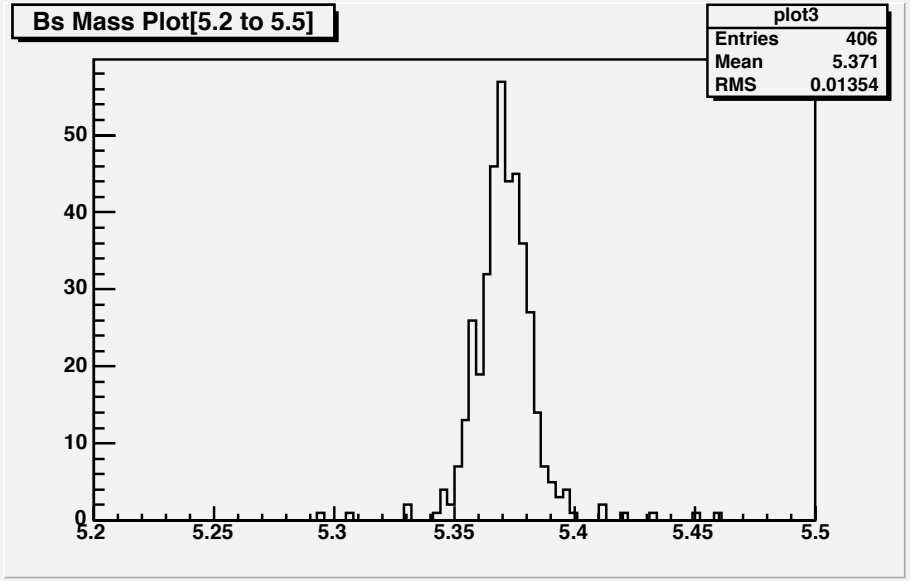
Setup environment
export CDFSoftRelease=6.1.4.m
export Executable=CandsExe-v80-6.1.4.m
export MasterTcl=mymaster.tcl
export TclFile=cvs_hadr.tcl
export DataSet=MC

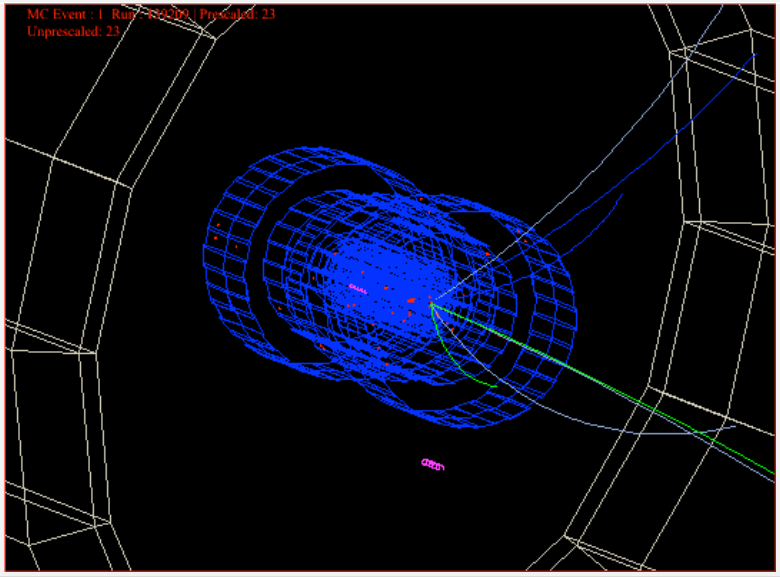
Setup CDFSoft
setup neurobayes_expert v2_3 -f Linux+2.4

Mass Plots from B-Standard Ntuple

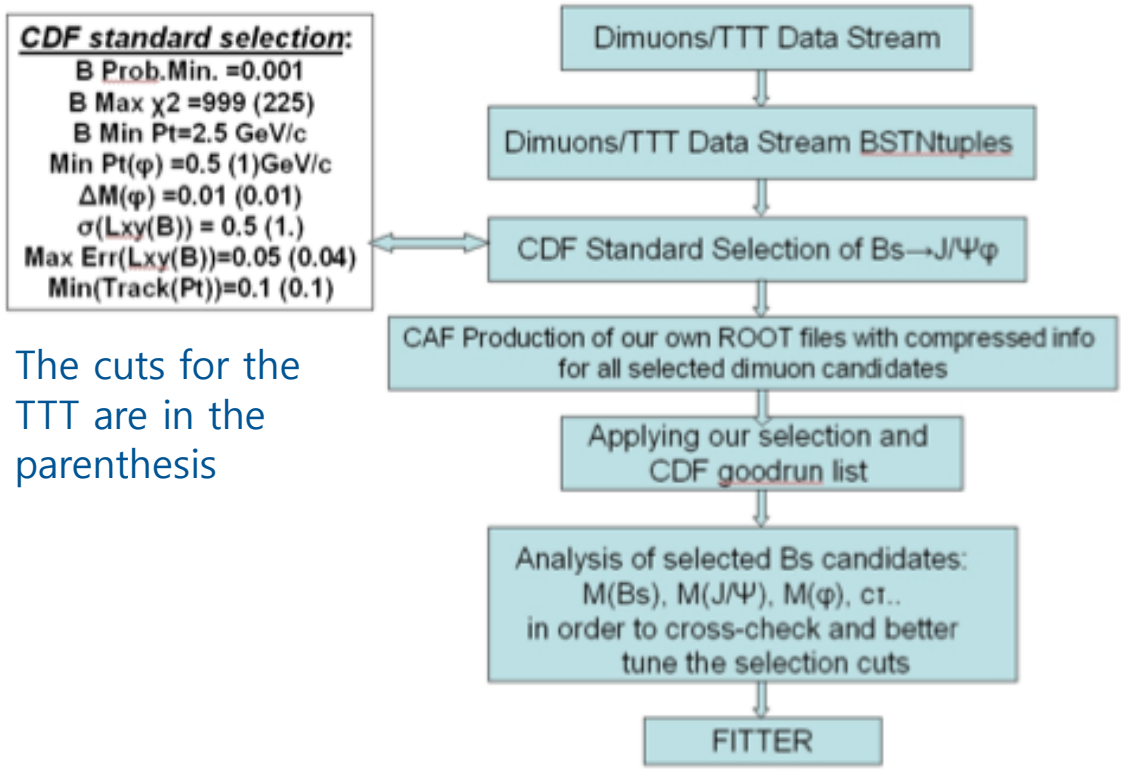








Flow DIAGRAM



This flow diagram in summarizes the procedure used for the data selection and analysis for both the two track trigger (TTT) and the dimuon trigger streams.

The selection follows into two stages.

First, corresponds to applying the so called standard CDF pre-selection for both data streams.

Selection cuts defining a Bs → J/Ψϕ candidates

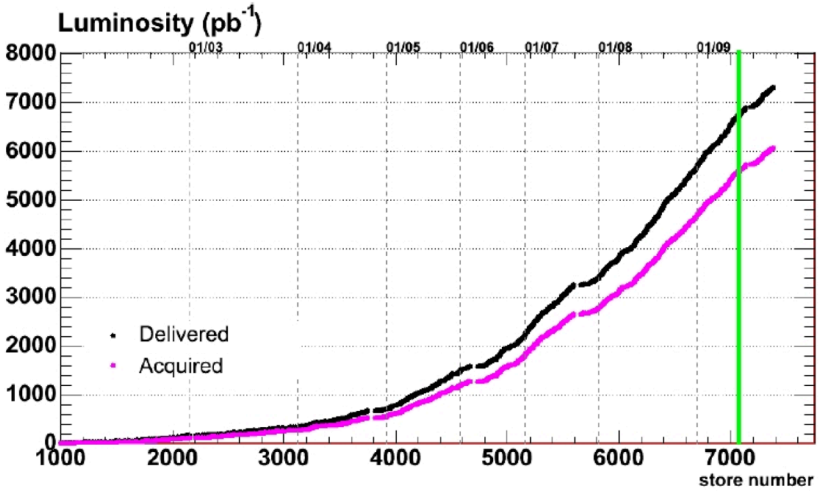
Second, refines the selection of Bs candidates on both data steams with slightly different cuts and still keeping rather loose requirements.

TTT	DIM
$5.24 < \mathrm{Mass}(B_s^0) < 5.4\ GeV/c^2$	$5.24 < \mathrm{Mass}(B_s^0) < 5.48\ GeV/c^2$
$2.95 < \mathrm{Mass}(J/\psi) < 3.25\ GeV/c^2$	$3.05 < \mathrm{Mass}(J/\psi) < 3.15\ GeV/c^2$
$P_t(J/\psi) > 2.00\ GeV/c$	$1.01 < \mathrm{Mass}(\phi) < 1.03\ GeV/c^2$
$P_t(\phi) > 1.36\ GeV/c$	$P_t(B_s^0) > 2.50\ GeV/c$
At least one identified muon	$P_t(K) > 1.00\ GeV/c$
$\chi^2_{xy}(B_s) < 18$	
$d_0(B_s) < 65\ \mu m$	

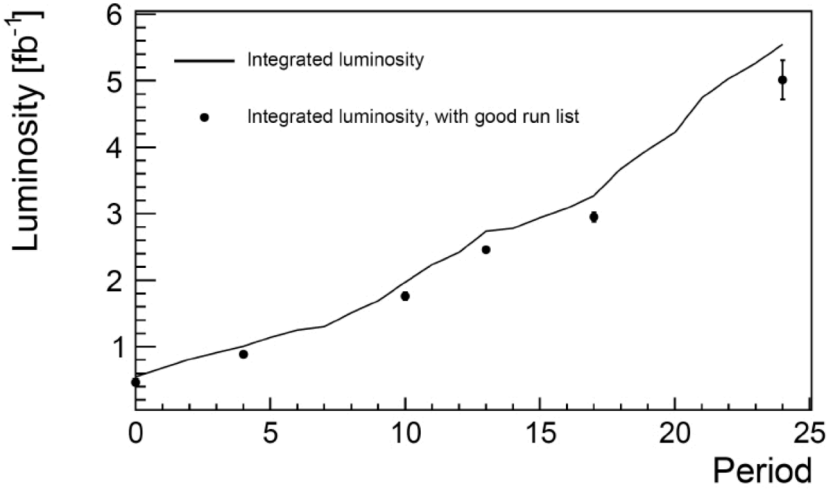
Table : summarizes the selection cuts defining a Bs → J/ψφ candidate for both data streams in our analysis

Integrated Luminosity

The data considered correspond to the time range between the beginning of Run II and Oct. 25th 2009 (period 0 to 26). The total recorder integrated luminosity by CDF from periods 0 to 26 is 4.2 fb^{-1}.
The goodrun list version 32, as created on March 12th 2010 is applied here and the total integrated luminosity after applying the goodrun list is 5.0187 fb^{-1}.

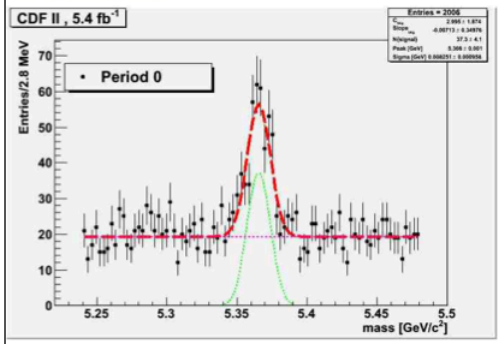


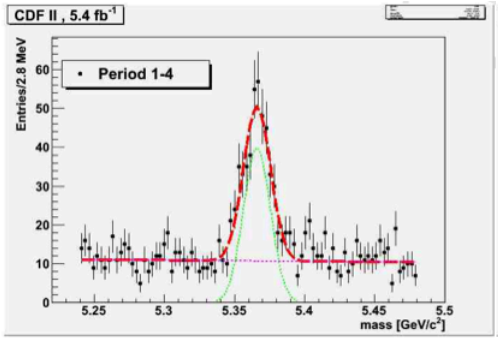
Delivered and acquired luminosity at the CDF experiment (period 0-24)

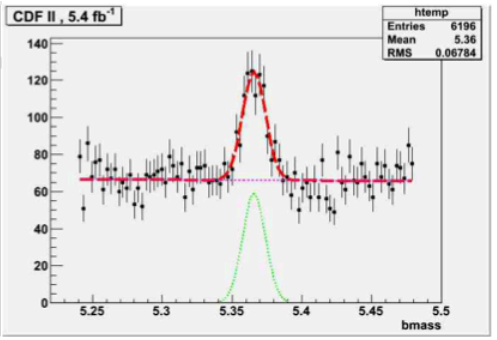


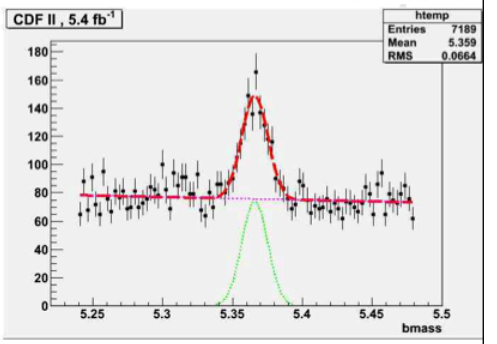
CDF integrated luminosity before (full line) and after (points) the application of the goodrun list (period 0-24)

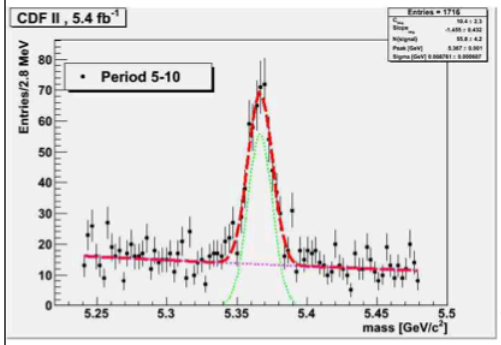
Bs Mass Spectrum Plots for TTT and Dimuon

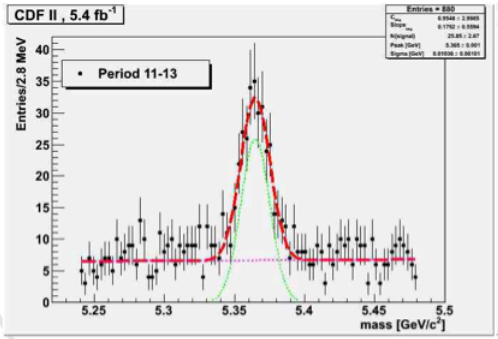


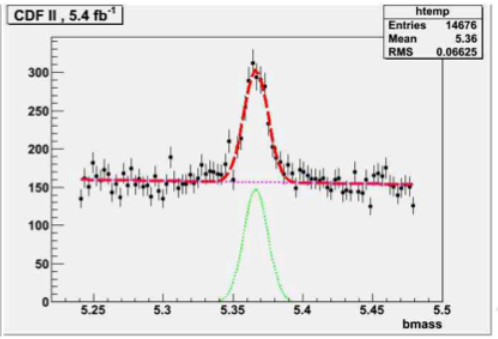


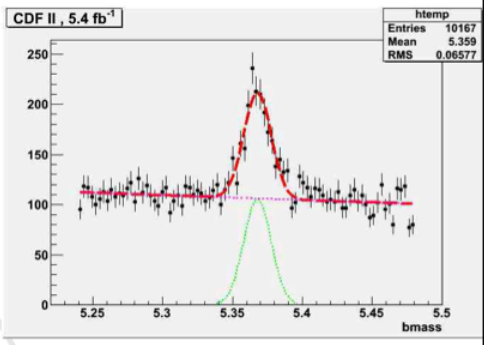


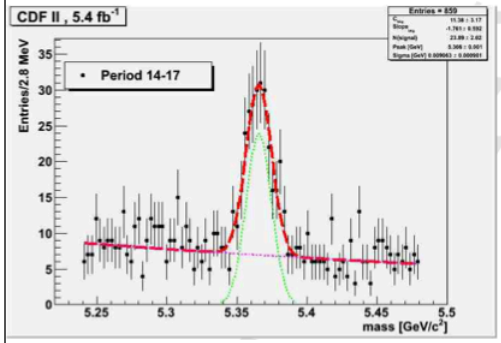


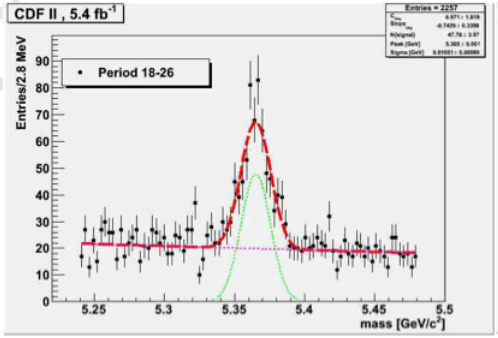


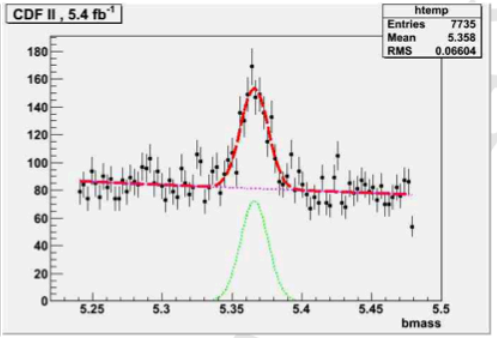


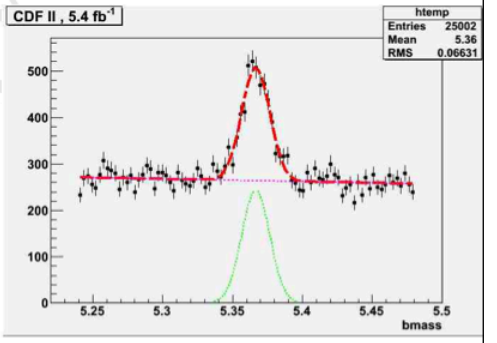








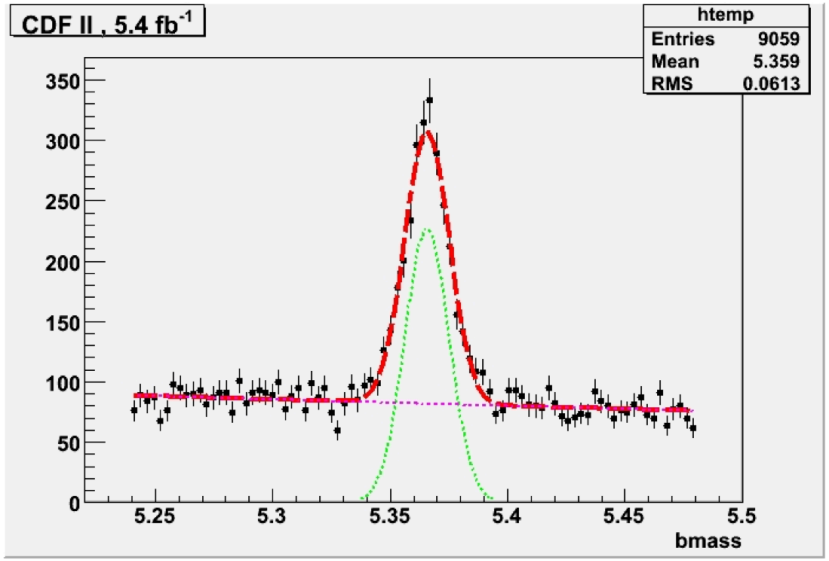


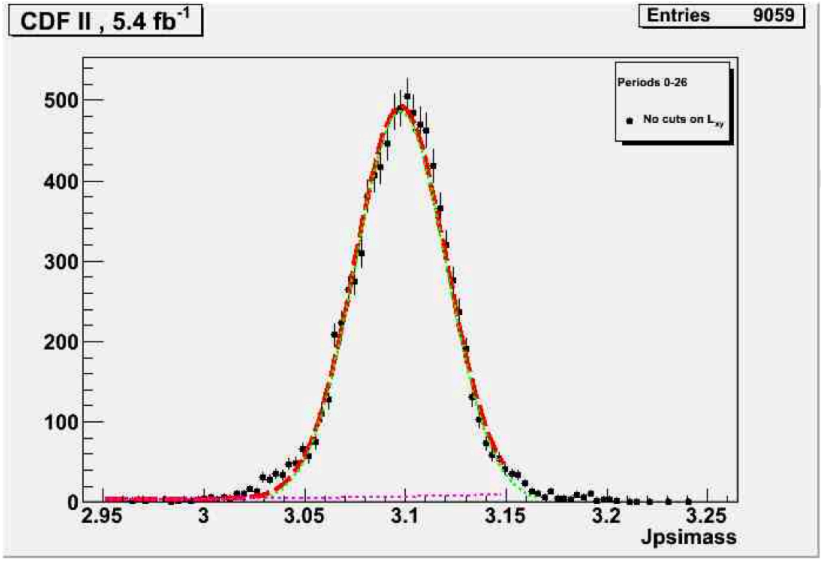


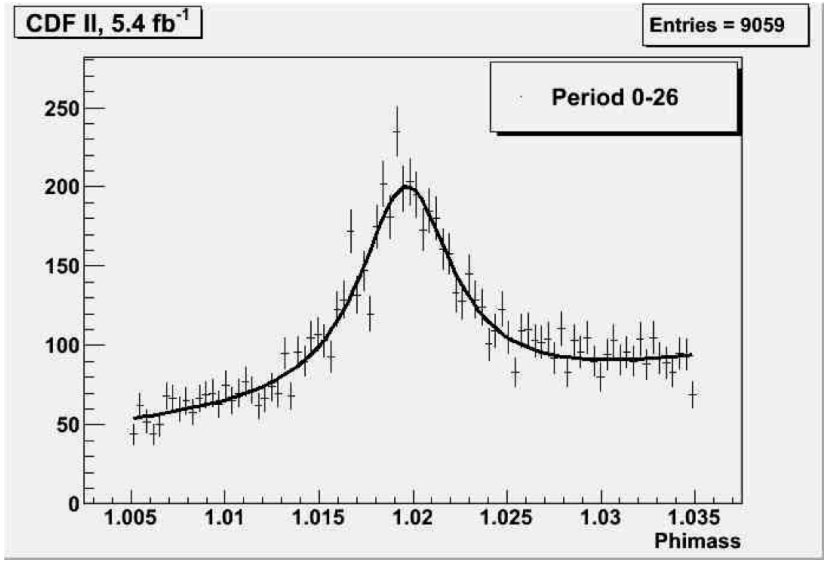
Bs mass spectrum after selection and exclusion of the overlapping events for each run period in the **TTT data sample** (period 0-26)

Bs mass spectrum after selection for each run period in the **Dimuon data sample** (period 0-26)

Mass spectrum of Bs, J/Ψ and φ in the TTT data sample



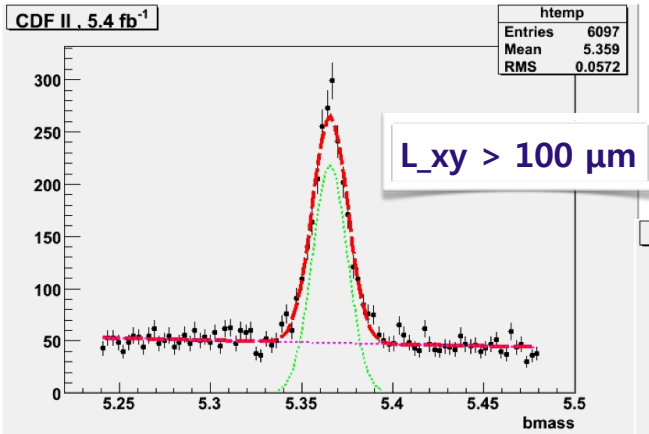


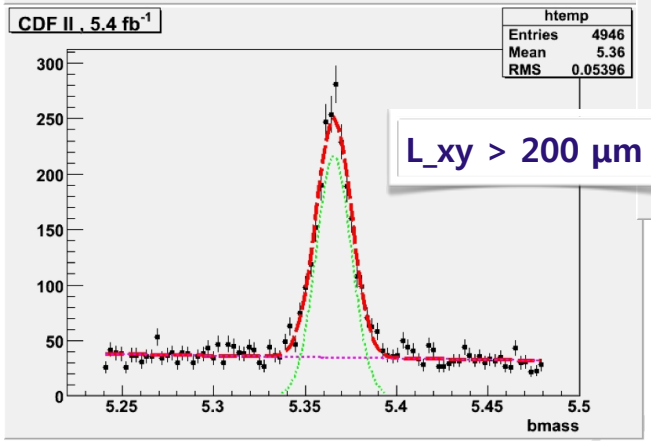


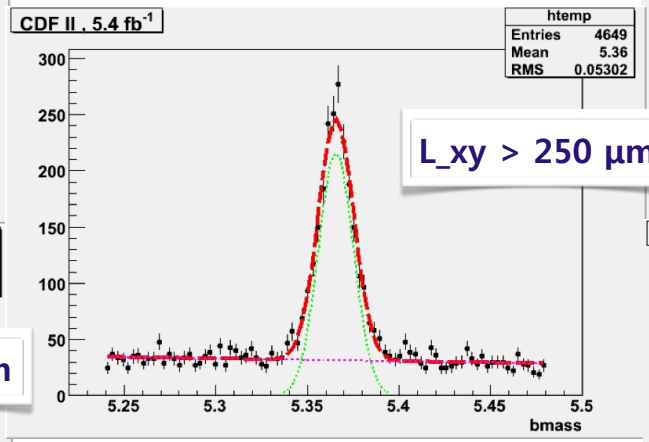
Effects of L_xy cuts on the Bs Sample

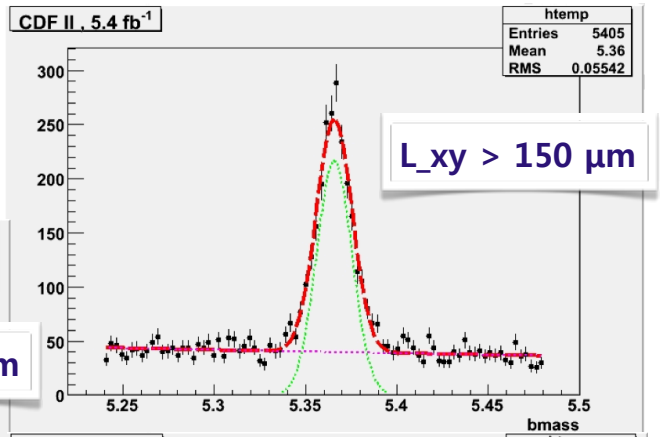
	Signal Events (S)	Background (B)	$S\sqrt{S+B}$
No cuts on L_{xy}	1889 ± 142	1634	31.8
$L_{xy} > 100\mu m$	1846 ± 128	971	34.8
$L_{xy} > 150\mu m$	1856 ± 124	811	36.0
$L_{xy} > 200\mu m$	1844 ± 121	703	36.5
$L_{xy} > 250\mu m$	1837 ± 119	636	36.9
$L_{xy} > 290\mu m$	1837 ± 118	589	37.3

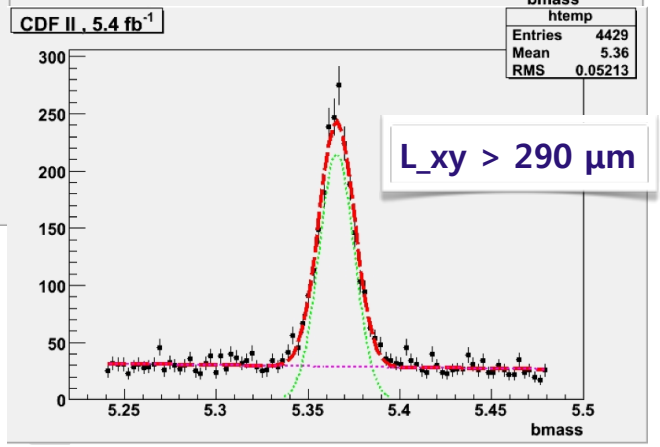
The Number of events in the TTT data stream for different cuts on L_xy of the Bs candidates





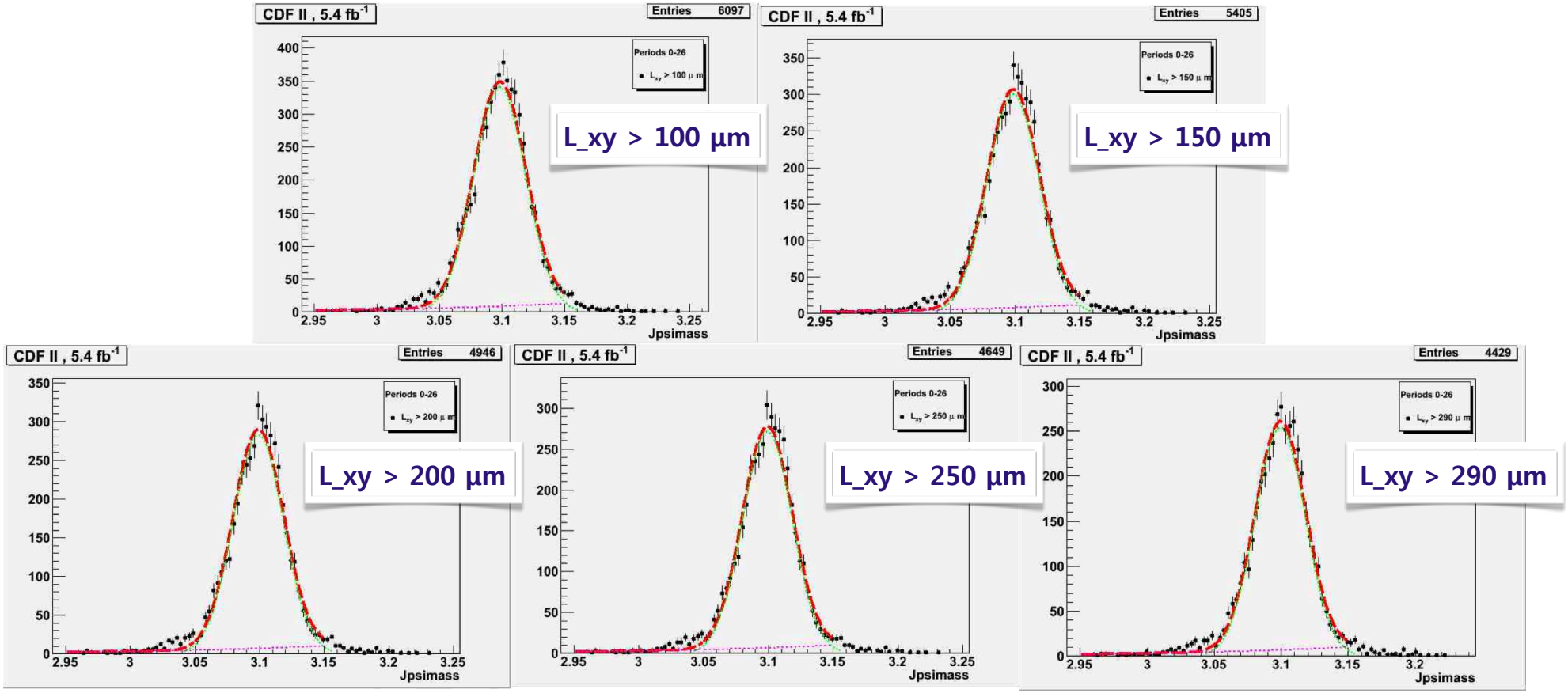






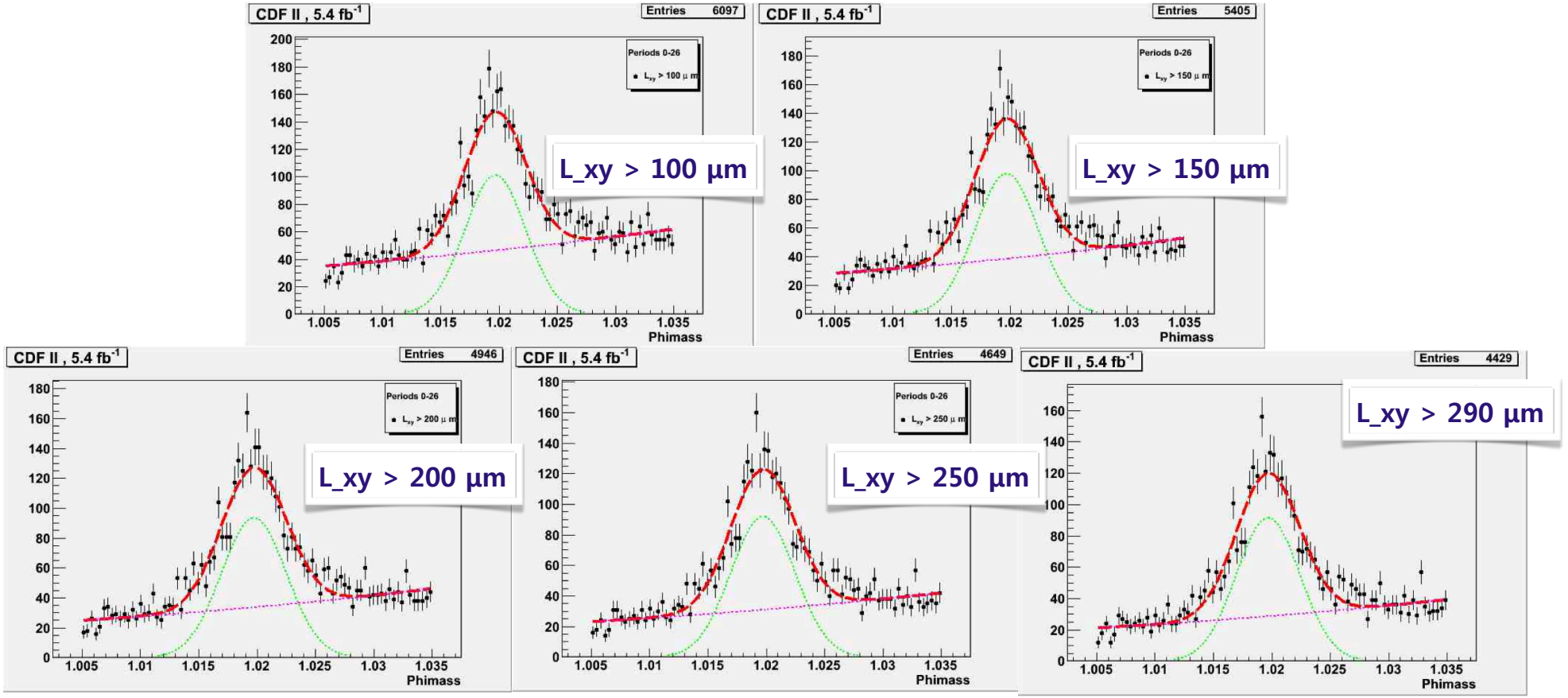
Mass Spectrum of the J/ψ

Mass Spectrum of the J/ψ for similar cuts on L_xy in the TTT data sample (period 0-26)



Mass Spectrum of the φ

Mass Spectrum of the φ for similar cuts on L_xy in the TTT data sample (period 0-26)



Results

The TTT provides as a signal (±3σ) a total of 1914 events (excluding overlaps) over a background (±3σ) of 1690 events, over the full period 0 to 26.

In the same run period we are left with a total of 5932 events from the dimuons.

This meaning that the TTT data are bringing 32.2 % more events to the analysis.