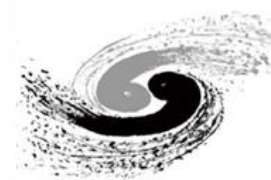


$B_c \rightarrow J/\psi \mu \mu$ analysis

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Experimental status



Collab.	$\mathcal{L}_{\text{int}}$ [pb $^{-1}$]	Mode	Signal event	Mass [MeV/ c^2]	Lifetime [ps]
CDF[24][25]	110	$J/\psi \ell^+ \nu$	$20.4^{+6.2}_{-5.5}$	$6400 \pm 390 \pm 130$	$0.46^{+0.18}_{-0.16} \pm 0.03$
D0[26] [†]	210	$J/\psi \mu^+ X$	$95 \pm 12 \pm 11$	$5950^{+140}_{-130} \pm 340$	$0.45^{+0.12}_{-0.10} \pm 0.12$
CDF[27]	360	$J/\psi \pi^+$	14.6 ± 4.6	$6285.7 \pm 5.3 \pm 1.2$	—
CDF[30]	360	$J/\psi e^+ \nu_e$	238	—	$0.463^{+0.073}_{-0.065} \pm 0.036$
CDF[28] [‡]	2400	$J/\psi \pi^+$	108 ± 15	$6275.6 \pm 2.9 \pm 2.5$	—
D0[29] [†]	1300	$J/\psi \pi^+$	54 ± 12	$6300 \pm 14 \pm 5$	—
D0[31] [†]	1300	$J/\psi \mu^+ X$	881 ± 80	—	$0.448^{+0.038}_{-0.036} \pm 0.032$

[†]: D0 preliminary

[‡]: CDF preliminary

LHC: p-p collisions at ECM = 14.0 TeV,

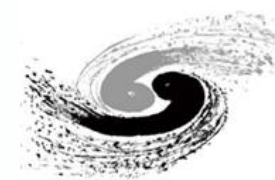
Initial L $\sim 2 \times 10^{32}$ cm $^{-2}$ s $^{-1}$, nominal L $\sim 1 \times 10^{34}$ cm $^{-2}$ s $^{-1}$

CMS: Competition with ALICE, LHCb, (ATLAS)...

but...CMS has excellent muon system, tracker, large acceptance!

Most analyses here based on medium and high PT muons

Event generation



- Signal: $B_c \rightarrow J/\psi \mu$, $J/\psi \rightarrow \mu\mu$ generated with BCVEGPY 2.1 generator

[Chang&Wu, EPJC38:267,2004]

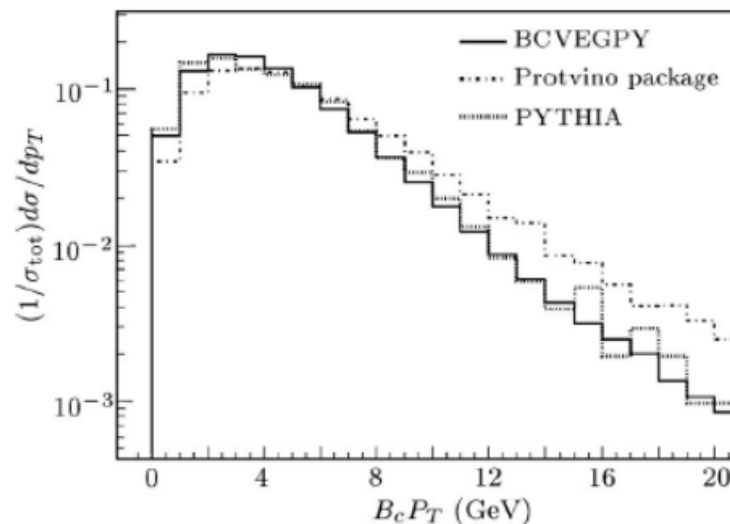
GeneratorInterface/GenExtension(BCVEGPY 2.1) in CMSSW_3_1_x

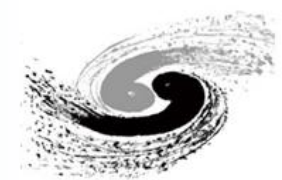
<https://twiki.cern.ch/twiki/bin/view/CMS/BcGenerator>

<http://indico.cern.ch/getFile.py/access?contribId=8&resId=0&materialId=slides&confId=52322>

I generate and analyze the signal
in CMSSW_2_2_3

- Generator cuts (simulate L1 and HLT trigger):
 - μ pair (from JPsi) $p_T \geq 2.5 \text{ GeV}$ $|\eta| \leq 2.5$
 $\text{InvMass}(3.096 \text{ GeV}, 3.098 \text{ GeV})$
 - Third μ (μ from B_c) $p_T \geq 2.5 \text{ GeV}$ $|\eta| \leq 2.5$



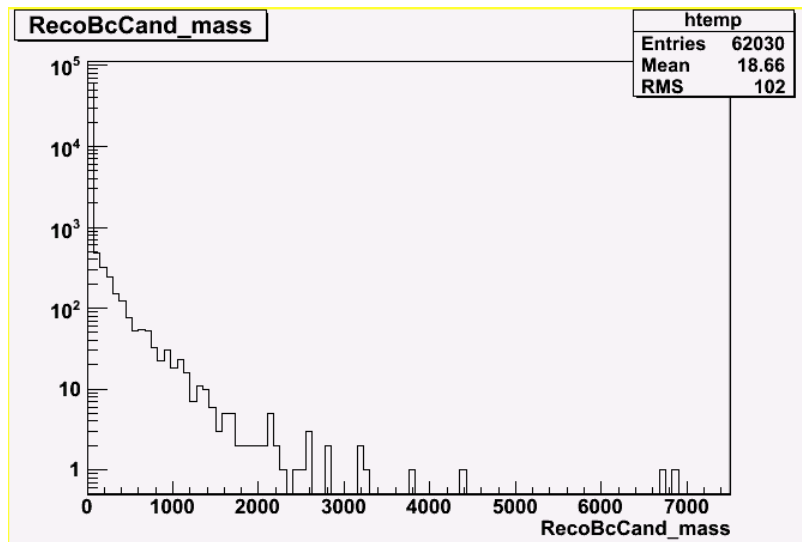
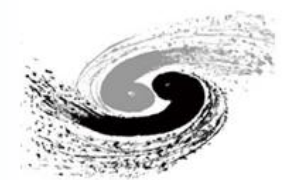


Related parameters

- $\text{Br}(pp \rightarrow b\bar{b}) = 1.16\%$
- $\text{Br}(b \rightarrow B_c) = 1.3 \times 10^{-3}$ [from HERWIG. Phys. Lett. B 266, 142 (1991).]
[E.g: Chang&Wu, EPJC38,267]
- Theoretical B_c cross section :
 $51.56 \text{ mb} \times 1.16\% \times 1.3 \times 10^{-3} \times 2 \approx 1 \mu\text{b}$
- $\text{Br}(B_c \rightarrow J/\Psi \text{ MuNu}) = 1.9\%$ $\text{Br}(B_c \rightarrow J/\Psi \pi) = 0.13\%$
- $\text{Br}(J/\Psi \rightarrow \text{MuMu} = 6\%) = 5.93 \pm 0.06\%$
- so three muon Branch = $1.9\% \times 5.93\% \approx 0.0012$
- Signal cross section: $1 \mu\text{b} \times 0.0012 = 1.2 \text{ nb}$
- After generate level filter.
Effective cross section: $1.2 \text{ nb} \times 0.057 = 0.0684 \text{ nb}$

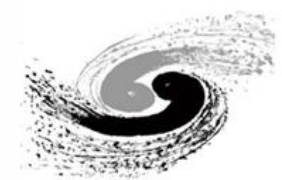
Filter efficiency
- So I asked for generate 2 fb^{-1} data in official
- There will be about 136800 effective Events

Generate and Reconstruction



- Generator cuts (simulate L1 and HLT trigger):
- Dimuon (from JPsi) $p_T \geq 2.5 \text{ GeV}$ $|\eta| \leq 2.5$
InvMass(3.096GeV, 3.098GeV)
- Third μ (μ from Bc) $p_T \geq 2.5 \text{ GeV}$ $|\eta| \leq 2.5$

	Signal		Inclusive B background	
	Events	Efficiency	Events	Efficiency
Generation	$2.4 \cdot 10^6$	-		
Gen-Sim-Reco	136610	0.057	2434076	
Dimuon select and vertex fit The three muon vertex fit	62030	0.454	47578	0.020



Select Criteria

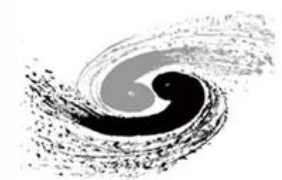
- Jpsi selection

track	$p_T > 1.5 \text{ GeV}/c$ 3 or more Si $r - \phi$ hits 2 or more axial COT SL 2 or more stereo COT SL
CMU muon	$\chi^2 < 9$
CMX muon	$\chi^2 < 9$
opposite charge	$q_1 \cdot q_2 = -1$

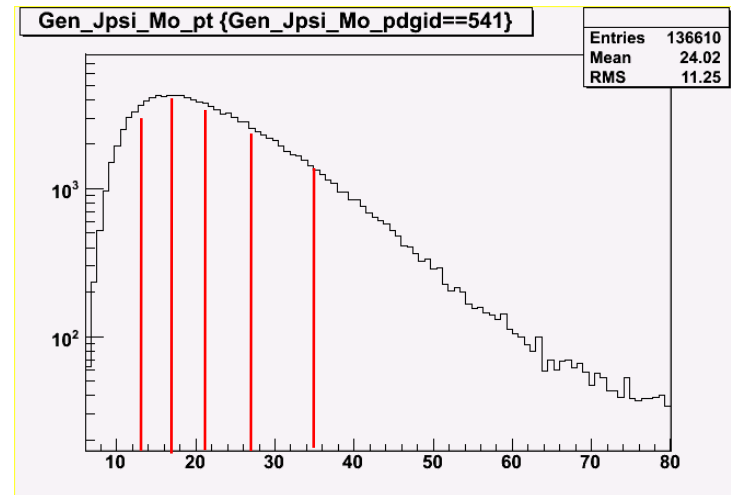
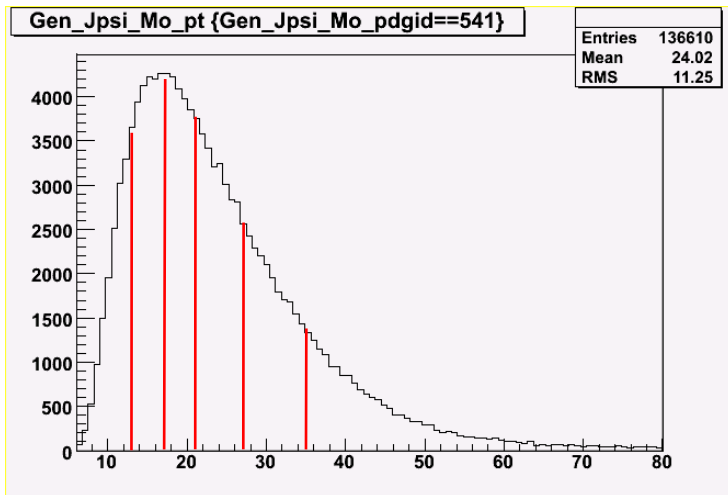
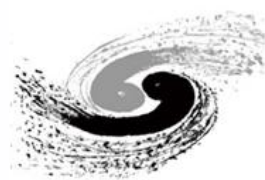
- Third muon selection

track quality	Si hits: ≥ 3 , COT Ax/St hits: ≥ 25
J/ ψ	within $\pm 50 \text{ MeV}/c^2$ around peak
third track	$p_T > 3.0 \text{ GeV}/c$ no track within 40 cm at CMU surface fiducial to CMUP
J/ ψ + track vertex	J/ ψ mass constrained $prob(\chi^2) > 1\%$ lifetime $c\tau > 60\mu$
kinematic	$\Delta\phi < \pi/2$
third muon	above quality requirements must be CMUP muon CMU $\chi_x^2 < 9$
remove $B^+ \rightarrow J/\psi K^+$	$ M(J/\psi + K) - M(B^+) > 50 \text{ MeV}/c^2$

Event selection

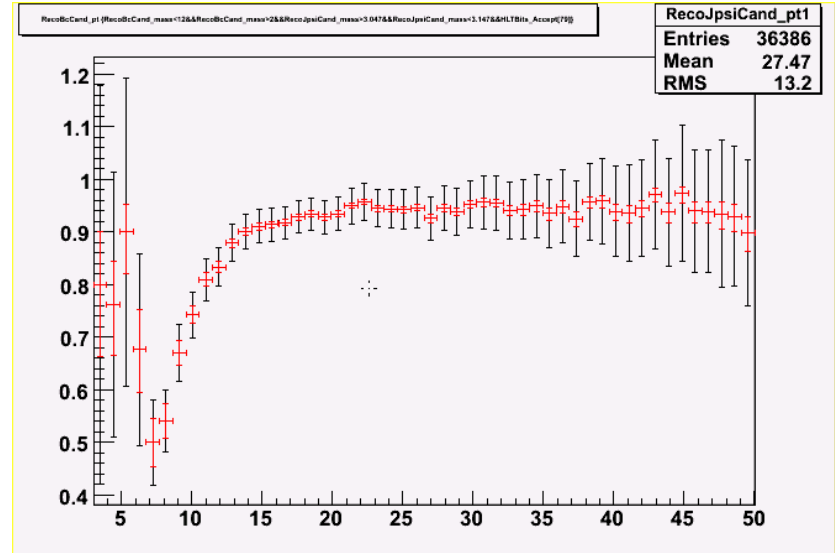
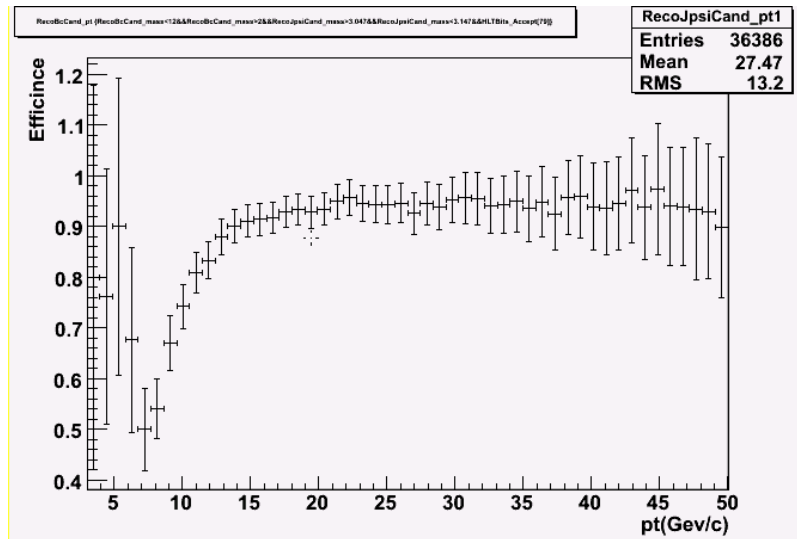
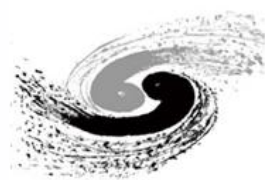


Candidate selection	Selection Criteria
Jpsi selection	
Trigger	HLT_DoubleMu3
Reco Object	Global muon
$p_T(\mu)$ (Gev/c)	>2.5
$ \eta(\mu) $	<2.4
Best dimuon candidate selection	Colsest mass
Same vertex dimuon mass window	(2.8,3.4)
Final selection	
Three muon Kerman vertex fit	yes
Bc Nomalized χ^2	<5
Fit strategy	
Discriminating variables	Mass, $c\tau$
$p_T(Bc)$ (Gev/c)	6-13,13-17,17-21, 21-27,27-35,Pt>35
Fit range: Bc Mass (Gev/c ²)	(3,8)
Fit range: $c\tau$ (cm)	(-0.04,0.1)



$6 < Pt < 13$, $13 < Pt < 17$, $17 < Pt < 21$
 $21 < Pt < 27$, $27 < Pt < 35$, $Pt > 35$

High level trigger



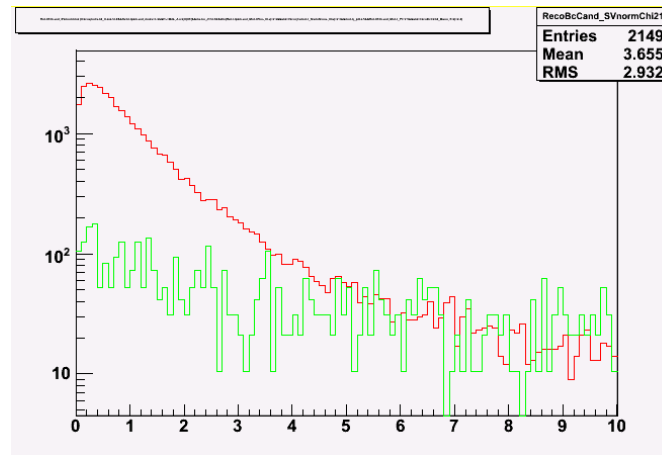
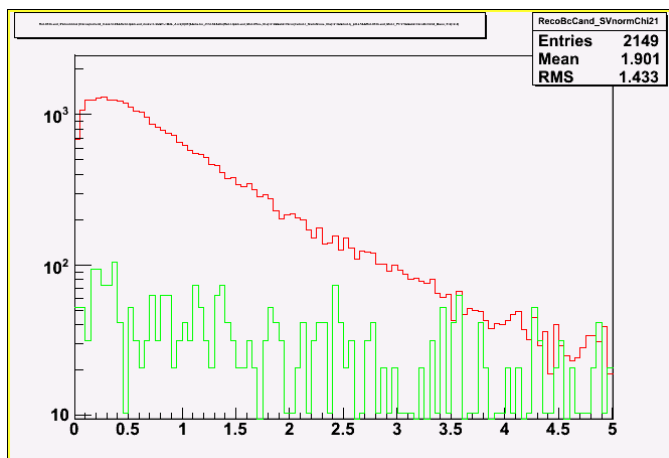
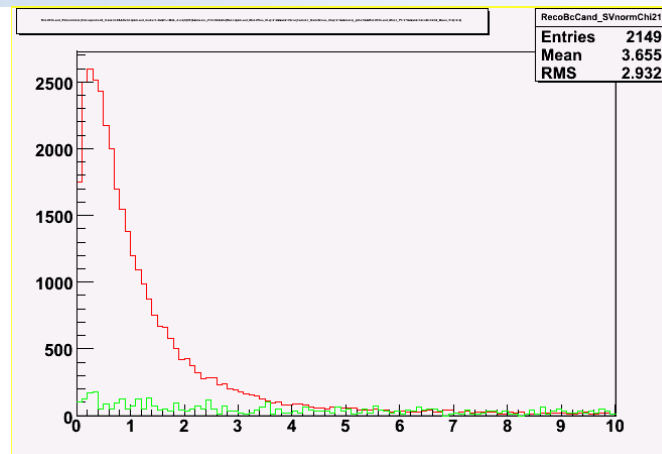
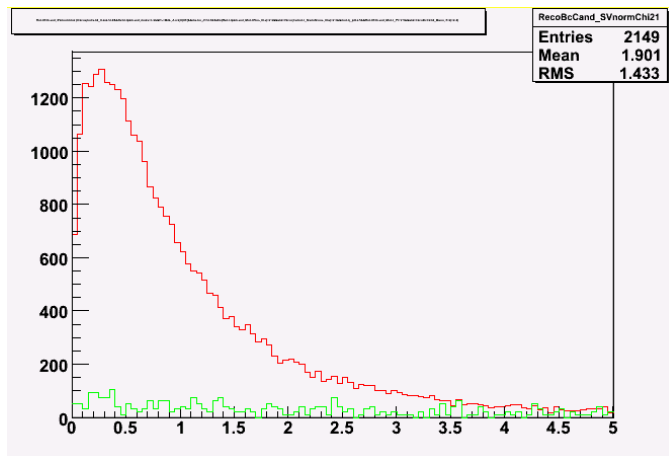
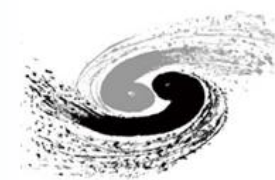
Bc High level trigger efficiency



- Select Criteria :
- 6) High level trigger HLT_Mu3

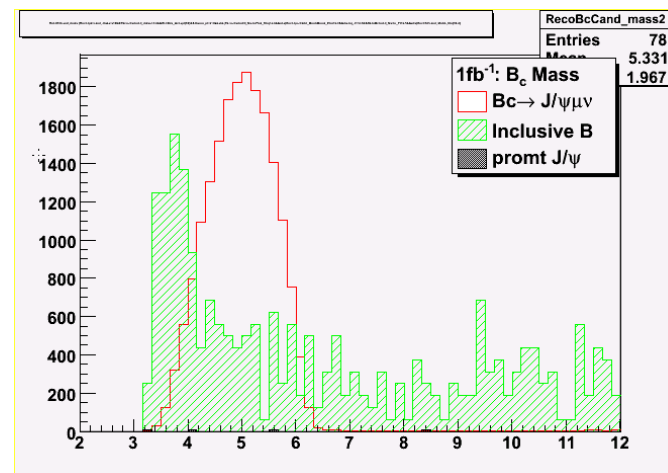
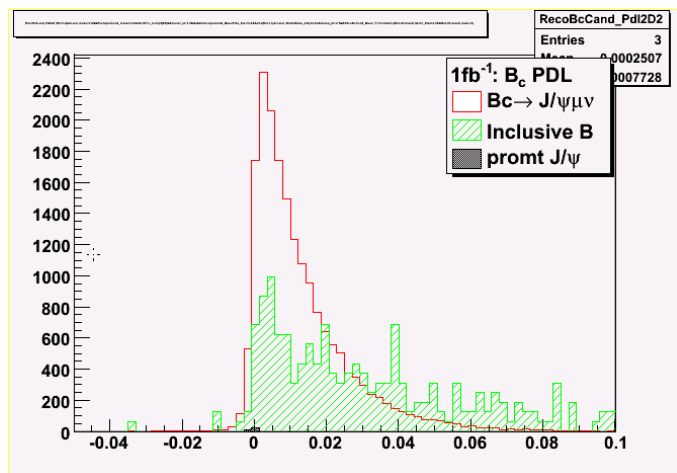


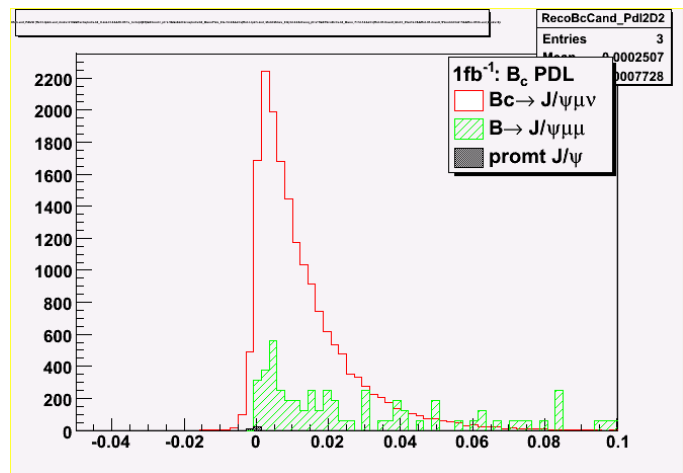
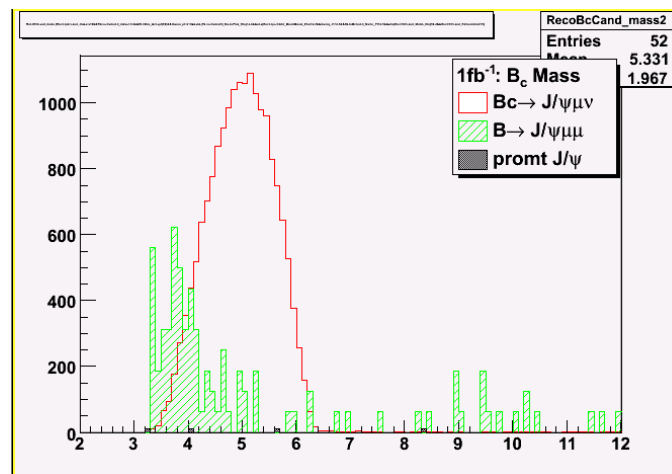
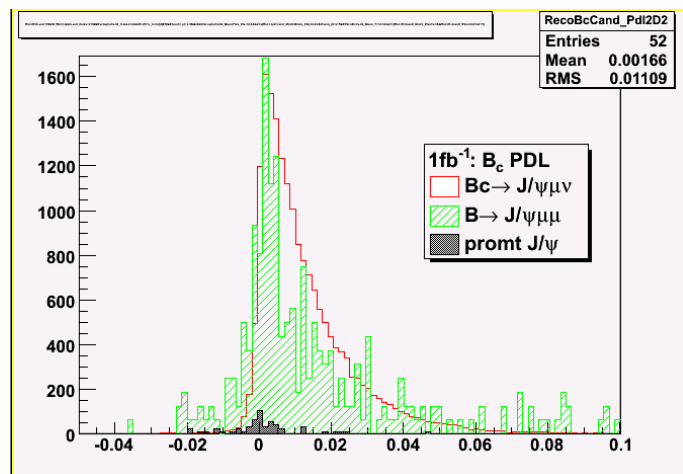
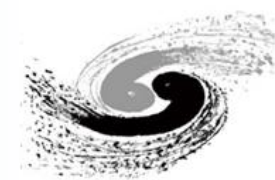
Bc normalized χ^2



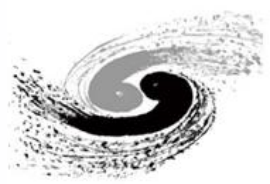
- Select Criteria :
- 9) Jpsi normalized $\chi^2 < 5(\chi^2/\text{ndof})$







Next step



- The mass and proper decay length Fit.
- Draw the efficiency.



Thank you!