

研究生季度考核

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2022年5月至8月



中国科学院高能物理研究所
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在LHCb上关于B和D介子关联产生截面的分析

- 效率修正
- 截面计算
- 误差处理

LHCb-PAPER-2022-028, Study of the $B^+ \rightarrow \Lambda_c^+ \bar{\Lambda}_c^- K^+$ decay *Yu Lu, Yiming Li, Jianchun Wang, Quan Zou (IHEP, CAS)* 进入**EB circulation**

中国高能物理分会学术年会 Poster

Plan for an upgrade Upstream Tracker at LHCb Upgrade II

BD 关联产生截面的分析

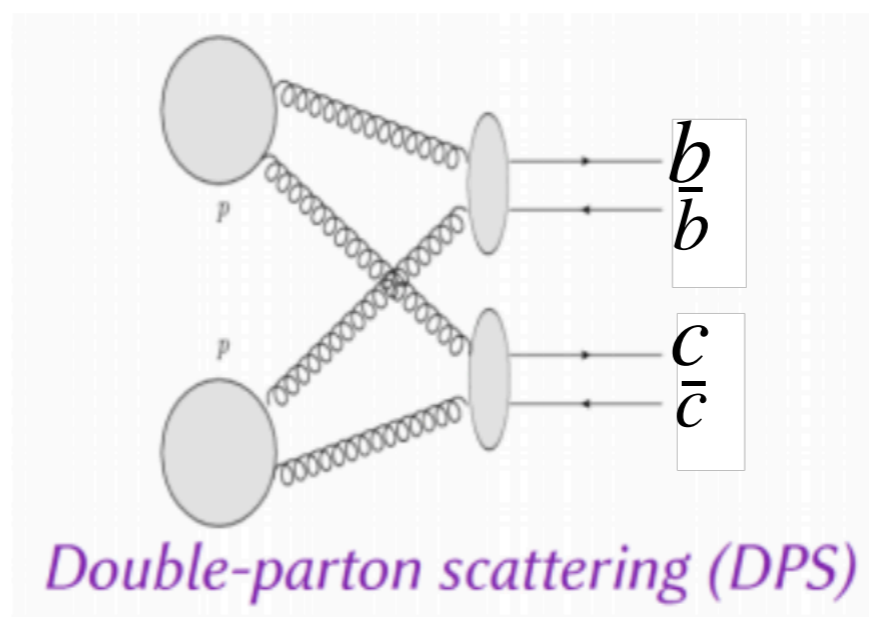
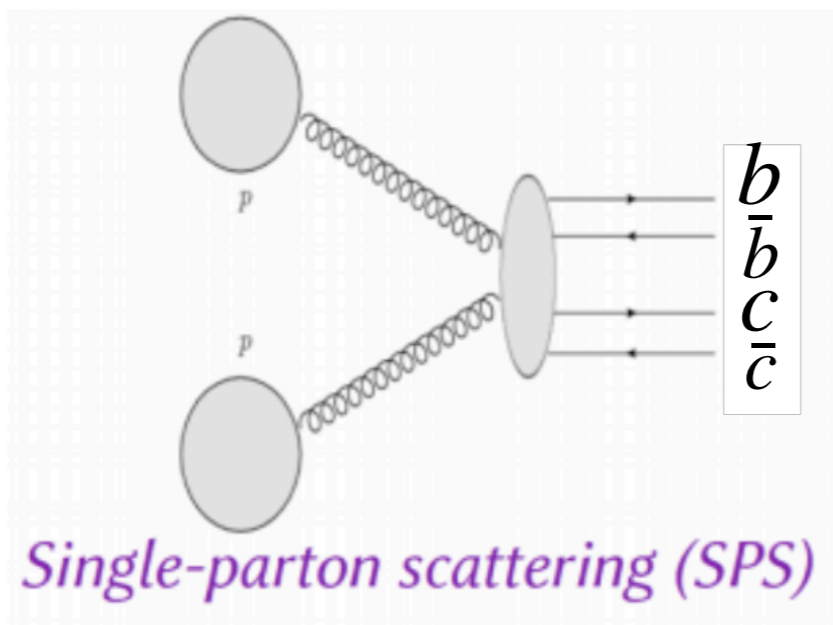
Jianchun Wang, Nathan Grieser, Quan Zou, Yiming Li

❑ **衰变道:** $pp \rightarrow B^\pm D^0 / \bar{D}^0 X$, with $B^+ \rightarrow J/\psi(\mu^+\mu^-)K^+$, $D^0 \rightarrow K^-\pi^+$

❑ **分析背景**

短期目标: $\sigma_{\text{eff}} (= \frac{\sigma_B \times \sigma_D}{\sigma_{\text{DPS}}})$

长期目标: 寻找可能的 B_c 和 T_{bc} 激发态



❑ **物理观测量:**
$$Br \times \frac{d\sigma^2}{dydP_T} = \frac{N_s(pp \rightarrow B^+ D^0 X)}{\mathcal{L}_{int} \times \epsilon_{tot} \times \Delta y \times \Delta P_T}$$

\mathcal{L}_{int} : 积分亮度

N_s : 拟合所得信号数目

ϵ_{tot} : 总效率

Br: 衰变道总分支比

测量道 $pp \rightarrow B^\pm D^0 / \bar{D}^0 X$

参考道 $pp \rightarrow B^\pm X$

□ 实验测量值

$$\sigma_{BD} = r \times \sigma_B$$

$$\sigma_{eff} = \frac{\sigma_B \times \sigma_D}{\sigma_{BD}} = \frac{\sigma_D}{r}$$

□ Fitting

□ PDG

□ Efficiency

$$\epsilon_t^D = \epsilon_{acc} \times \epsilon_{rec} \times \epsilon_{sel} \times \epsilon_{PID}$$

$$r = \frac{\sigma_{BD}}{\sigma_B} = \frac{N_{BD}^{fit}}{N_B^{fit}} \times \frac{1}{BF_{D \rightarrow K\pi}} \times \frac{1}{\epsilon_{totD}}$$

□ 参考道

$$pp \rightarrow B^{\pm} X$$

○ 选择条件

对于B channel, 参考道和测量道选择条件保持一致,
取消B channel的效率修正

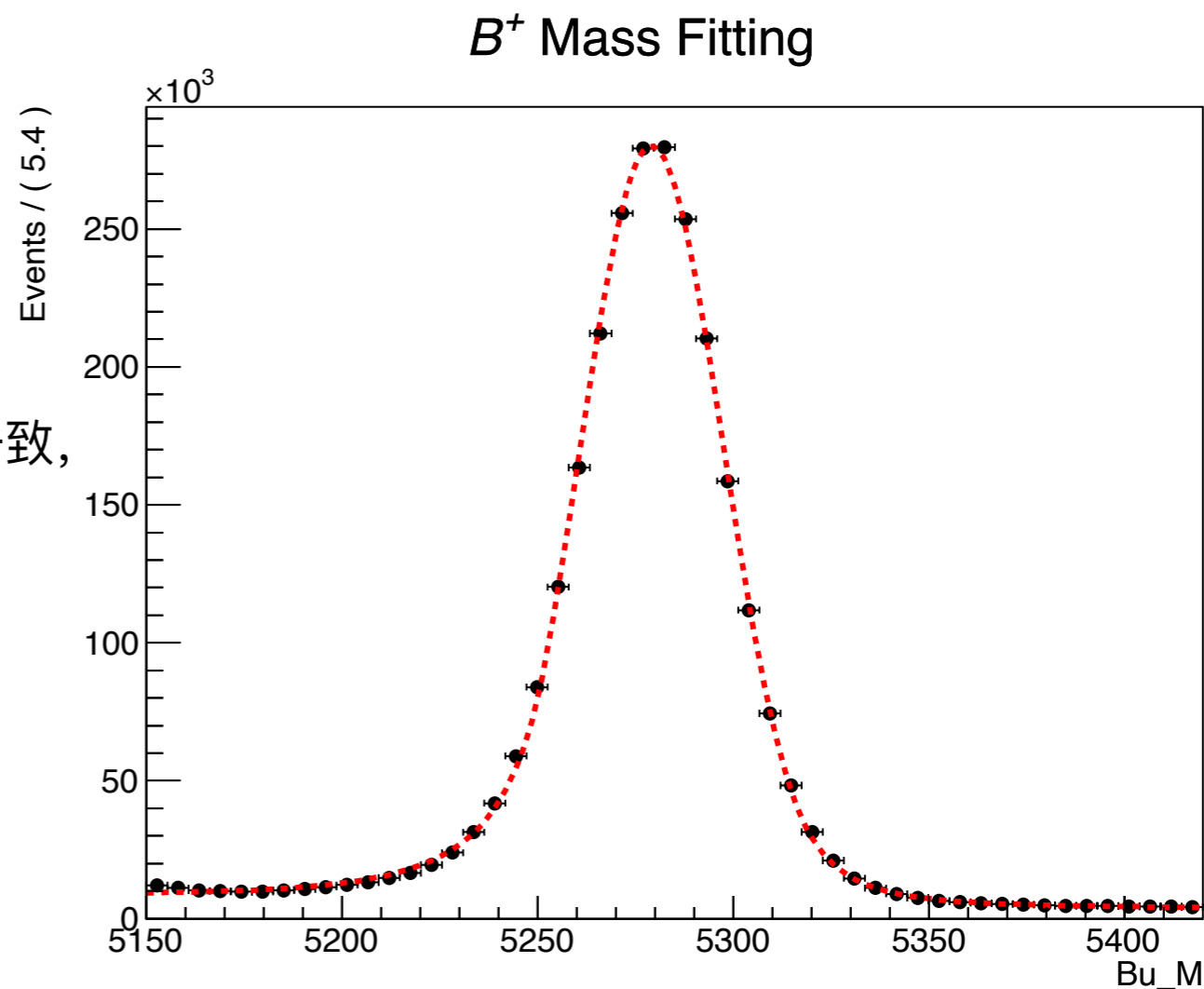
○ 拟合PDF

选择和测量道一致的PDF拟合质量谱

Double Sided Crystal Ball + Expo

○ Signal yields

2.45e+6



测量道

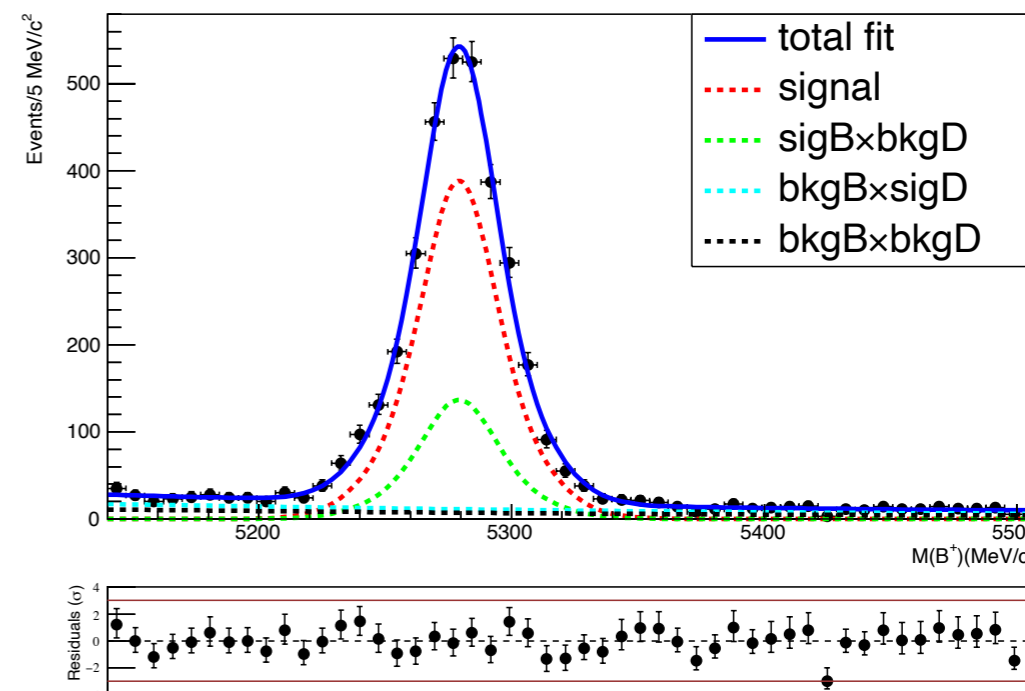
$$pp \rightarrow B^\pm D^0 / \bar{D}^0 X$$

二维质量谱拟合

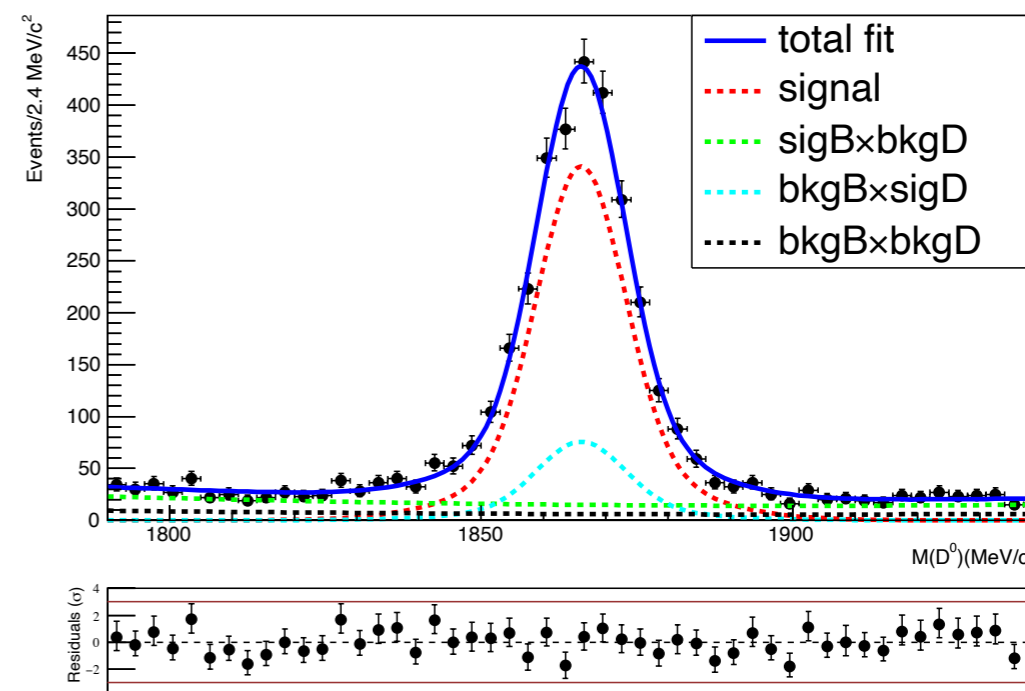
质量谱拟合去除组合本底

Combinations	signal yields	Error
$pp \rightarrow (B^+ D^0 X)_{cc}$	1429	45
$pp \rightarrow (B^+ \bar{D}^0 X)_{cc}$	725	37

B^+ Fitting

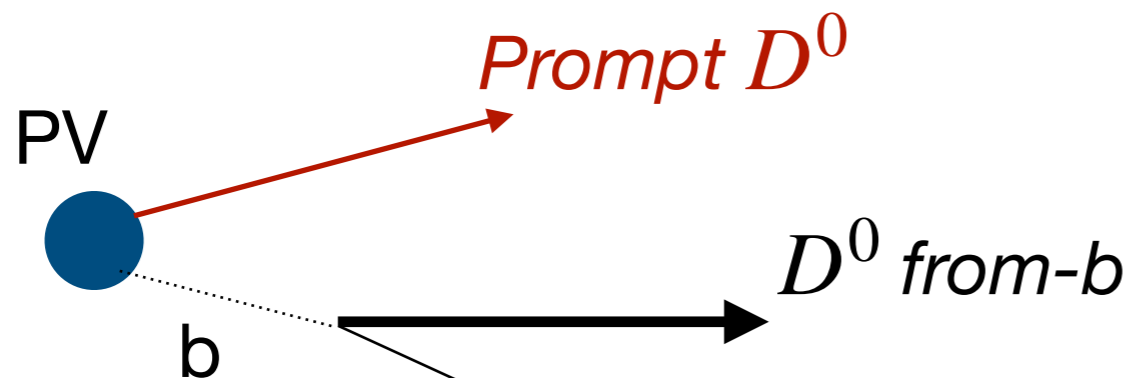


D^0 Fitting

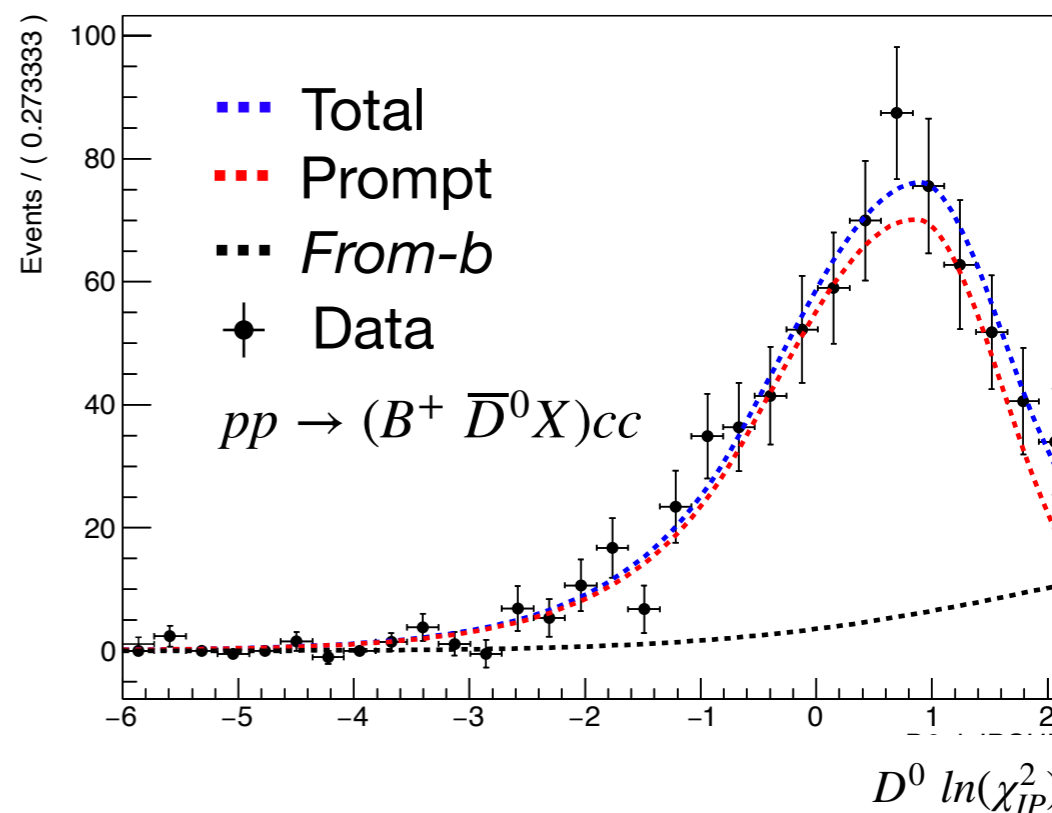
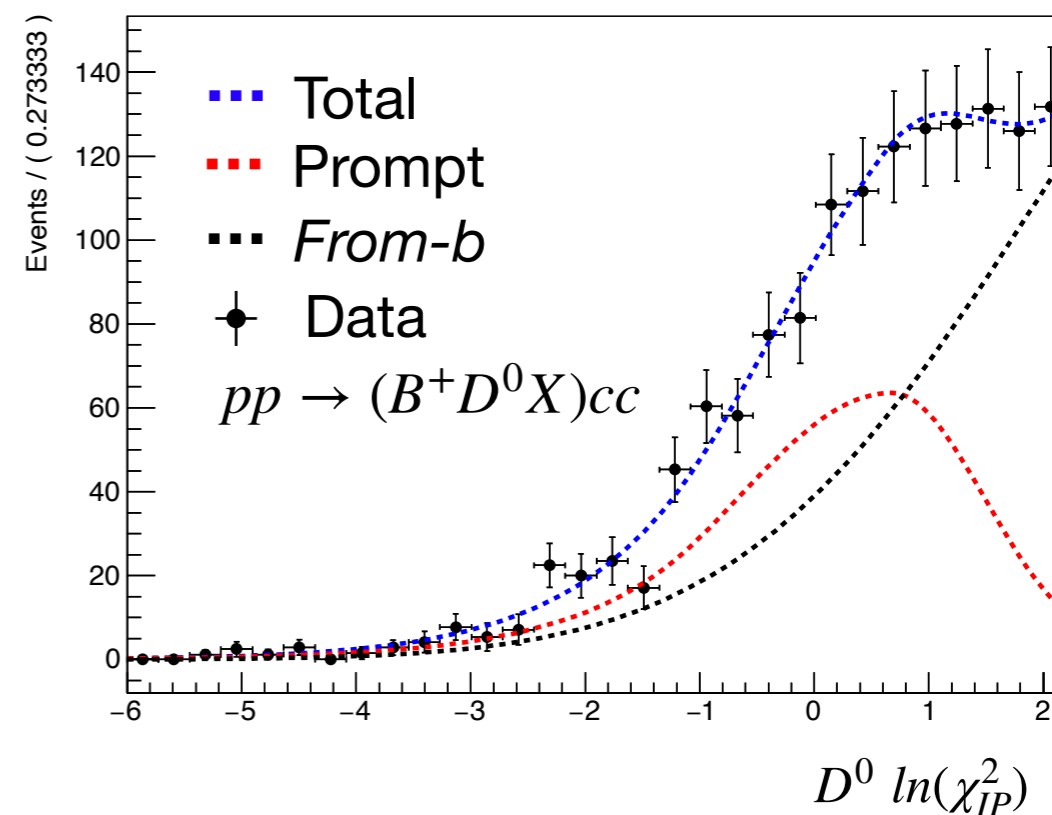


关于 D^0 的 $\ln(\chi_{IP}^2)$ 的拟合

质量谱的拟合去除组合本底后，
将带有sWeight的数据，
进行关于 $\ln(\chi_{IP}^2)$ 的拟合得到**prompt成分**

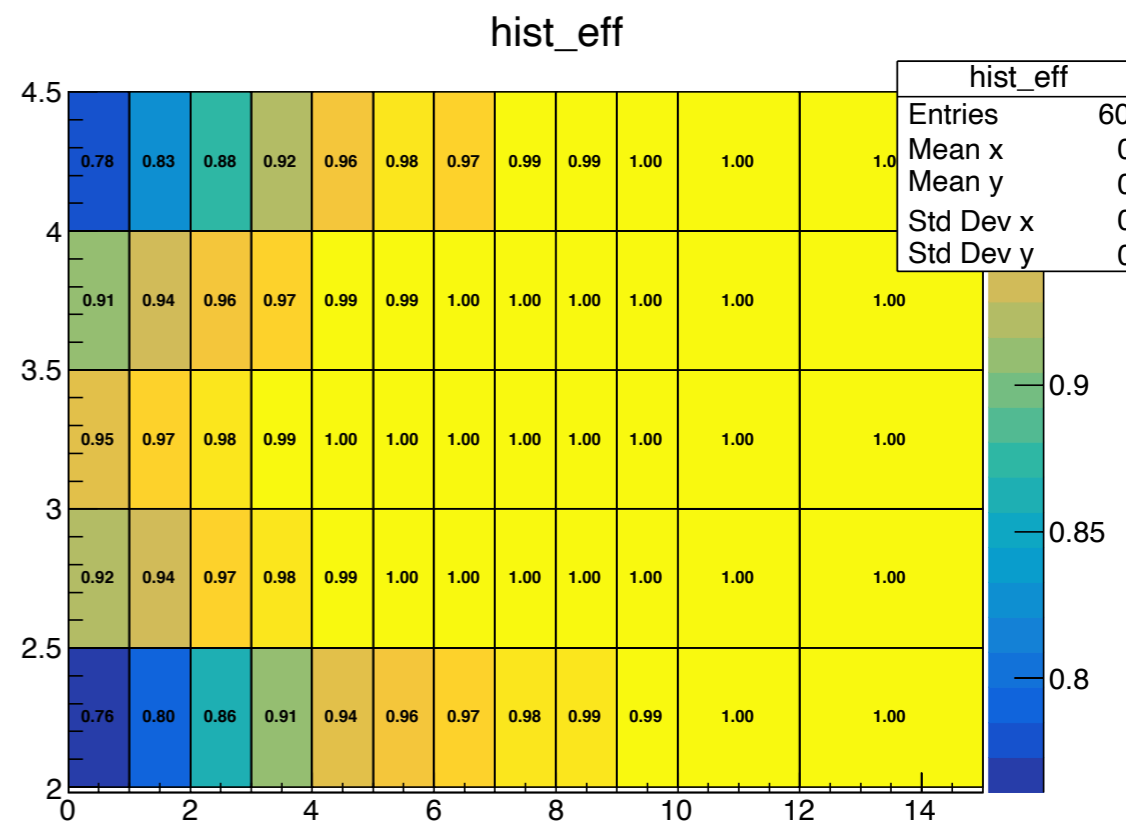
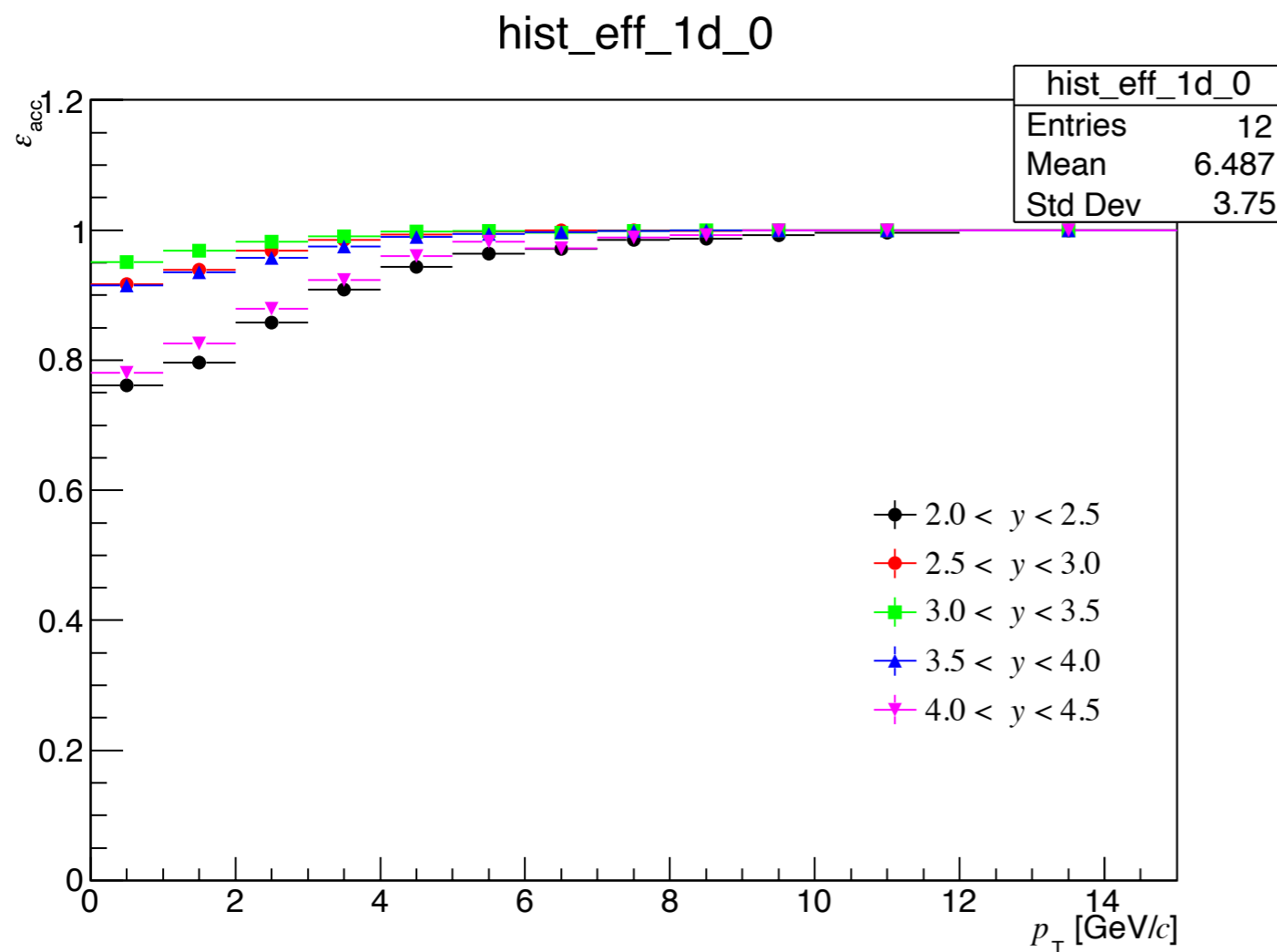


Combinations	f_{prompt}	Error
$pp \rightarrow (B^+ D^0 X) cc$	0.45	0.04
$pp \rightarrow (B^+ \bar{D}^0 X) cc$	0.89	0.04



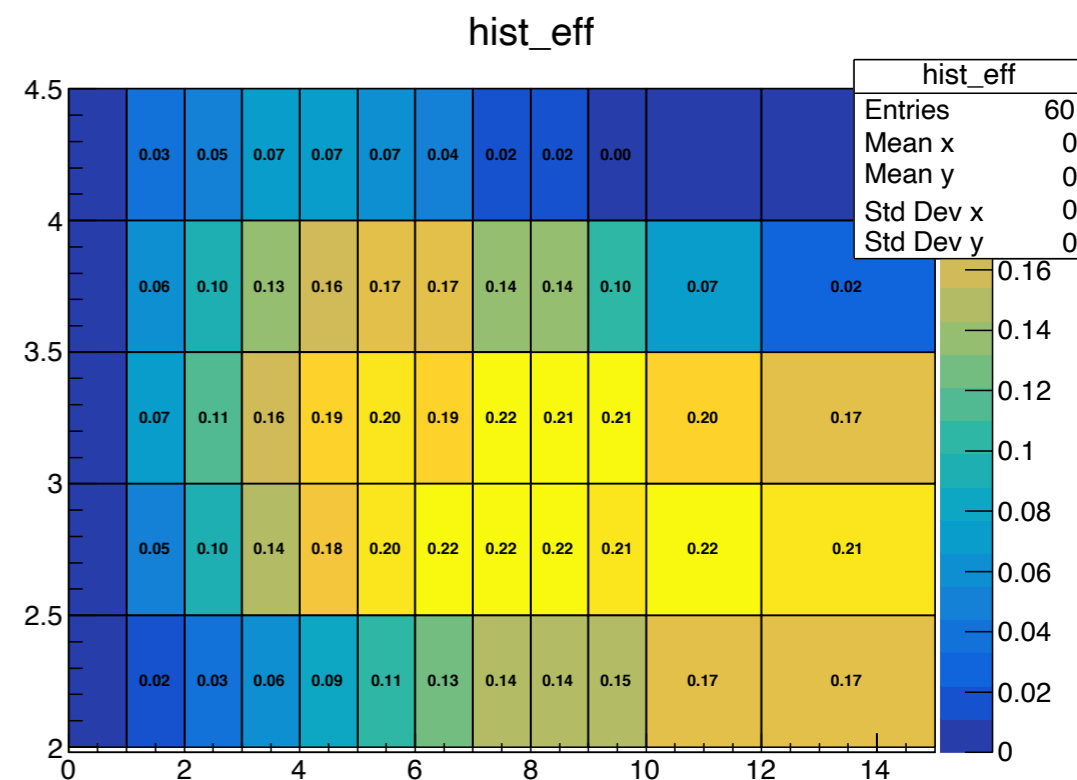
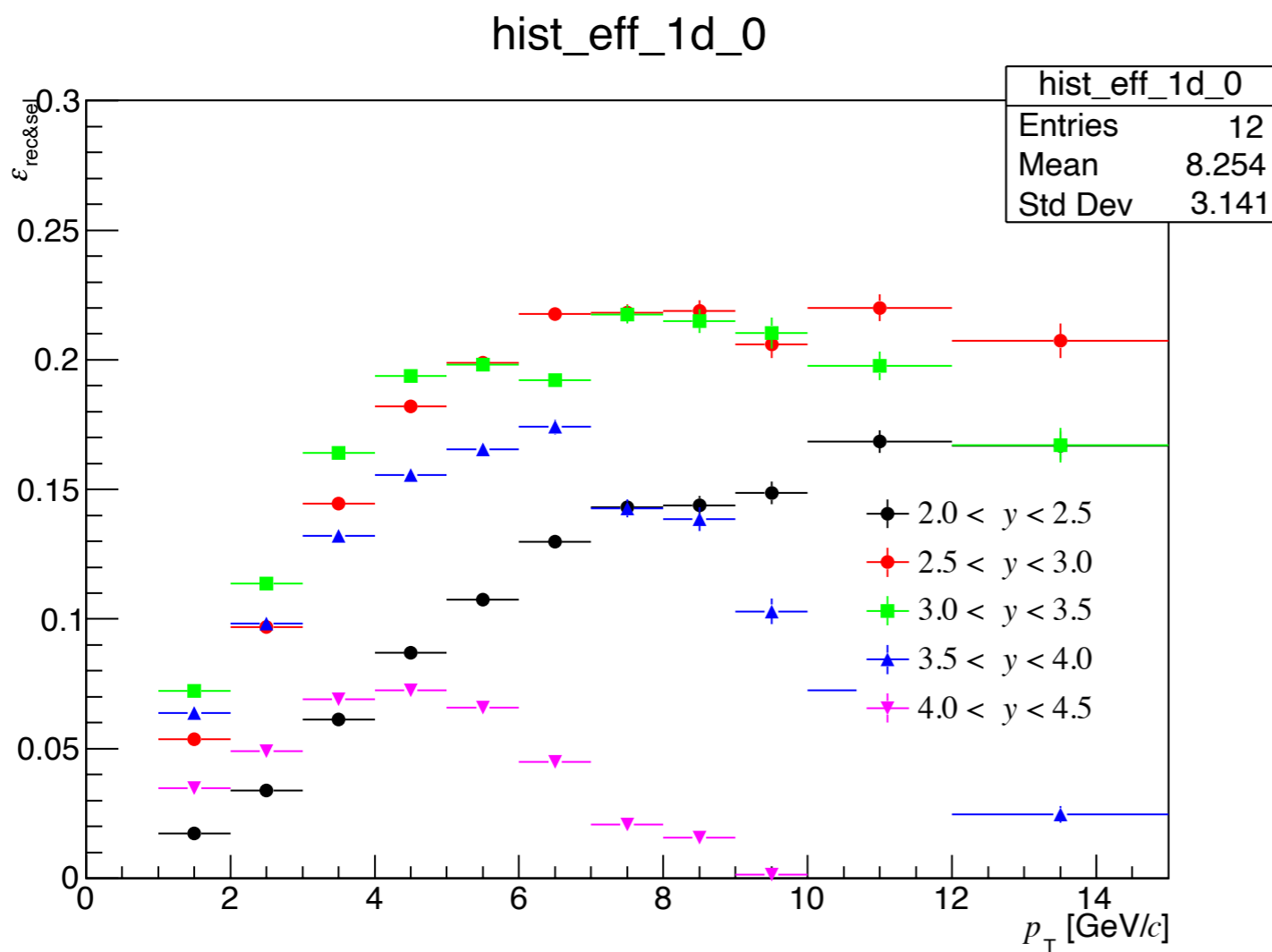
接收度效率

$$\epsilon_{acc} = \frac{\#all\ the\ final - state\ particles\ within\ 10 < \theta < 400mrad}{\#events\ generated}$$



重建和选择效率

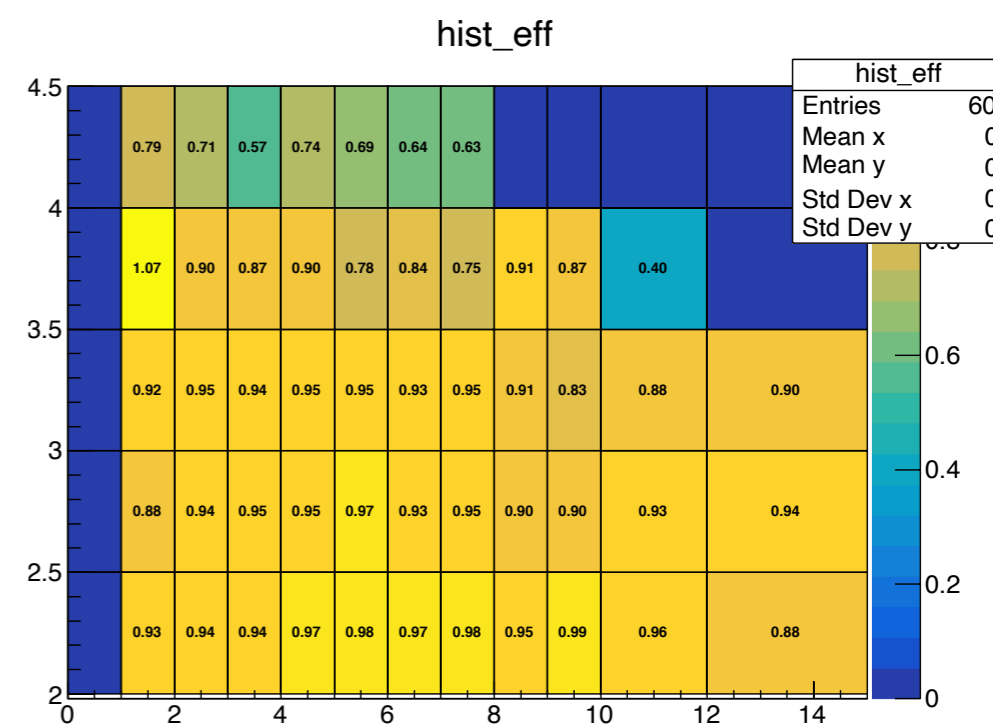
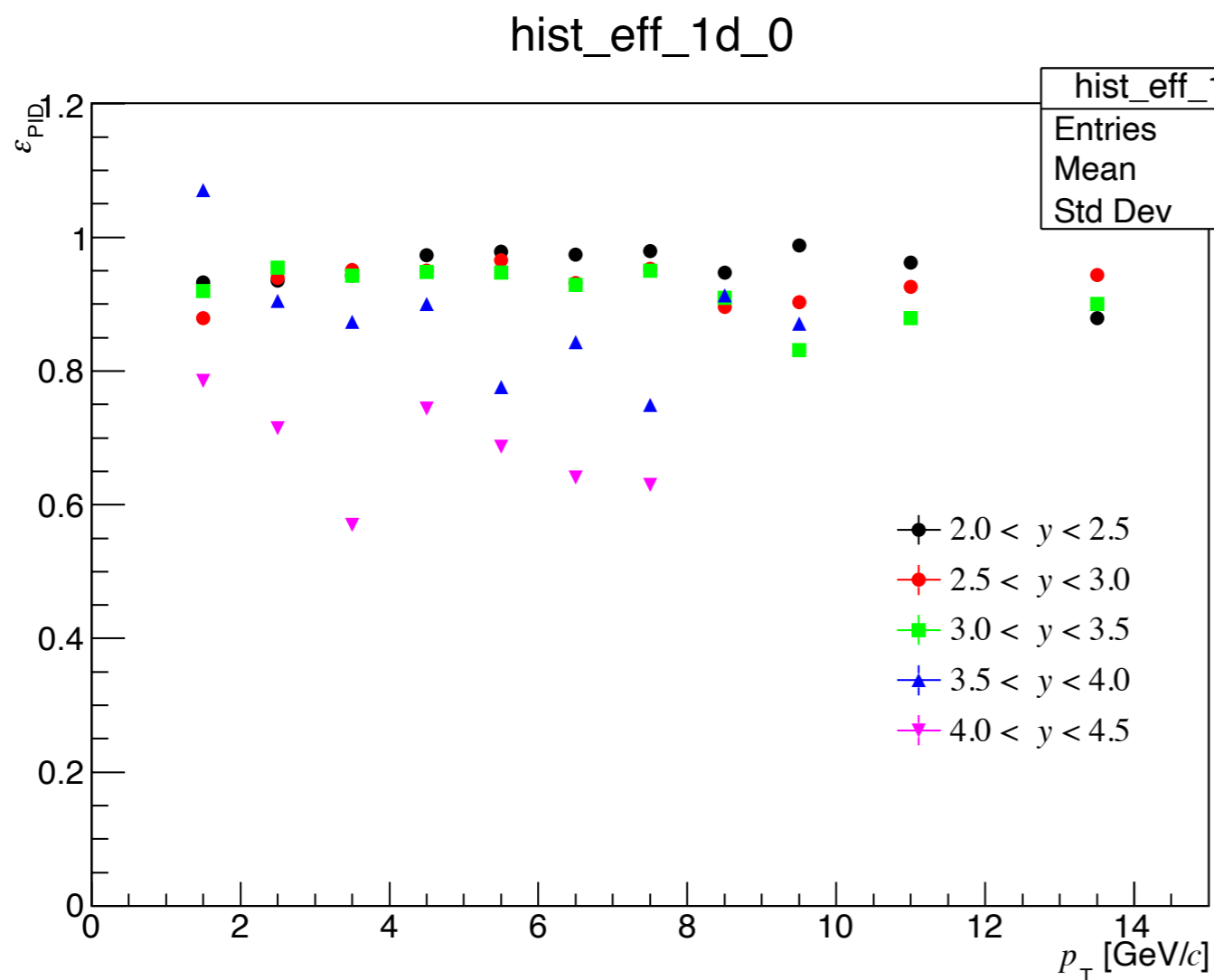
$$\epsilon_{rec\&sel} = \frac{\text{events reconstructed and selection w/o PID}}{\text{events accepted}}$$



粒子鉴别效率

Per-event PID efficiency is derived by PIDCalib2 Package

PID cuts $Kp_ProbNNk > 0.3 \& Bu_log1mDIRA < -4.56 \&$
 $KmD_ProbNNk > 0.3 \& D0_log1mDIRA < -4.0$



□ BD关联截面分析，完成截面和误差估计

计算微分截面和总截面

$$r = \frac{\sigma_{BD}}{\sigma_B} = \frac{N_{BD}^{fit}}{N_B^{fit}} \times \frac{1}{BF_{D \rightarrow K\pi}} \times \frac{1}{\epsilon_{totD}}$$

□ 误差处理

- Fit model
- f_{prompt} Determination
- Tracking efficiency
- PID efficiency
- Other systematic uncertainties from the input, like BR

- ❑ 物理分析：在LHCb上关于B和D介子关联产生截面的分析
准备WG报告和Analysis Note
- ❑ 物理分析： *LHCb-PAPER-2022-028, Study of the $B^+ \rightarrow \Lambda_c^+ \bar{\Lambda}_c^- K^+$ decay*
Yu Lu, Yiming Li, Jianchun Wang, Quan Zou (IHEP, CAS)
进入EB circulation
- ❑ 会议海报：中国高能物理分会学术年会 Poster
Plan for an upgrade Upstream Tracker at LHCb Upgrade II
- ❑ 会议报告：代表UT中国组在CLHCP上的报告(2021/11)
LHCb UT upgrade status
- ❑ 文章：LHCb UT group 在**Sensors**上发表文章(2021/12)
“The SALT—Readout ASIC for Silicon Strip Sensors of Upstream Tracker in the Upgraded LHCb Experiment”

THANK YOU!

官方stripping line的预选择

Table 1: MUON Cuts in FullDSTDiMuonJpsi2MuMuDetachedLine

code	meaning
(MINTREE('mu+'==ABSID,PIDmu) >0.0	PIDmu >0
MINTREE('mu+'==ABSID,PT) >500.0 MeV	PT >500MeV
"RequiresDet='MUON' IsMuon=True"	long track

Table 2: Jpsi Cuts in FullDSTDiMuonJpsi2MuMuDetachedLine

code	meaning
abs(BPVDLS)>3	Decay length significance >3
ADOCACHI2CUT(30,")	$\chi^2_{DOCA} < 30$
VFASPF(VCHI2PDOF)<20.0	End vertex $\chi^2_{endvt} < 20$
(MM >2996.916) &(MM<3196.916)	mass constraint
ADAMASS('J/psi(1S)') <100 MeV	same as above

WGP及进一步的选择条件

Table 3: cuts in WGP

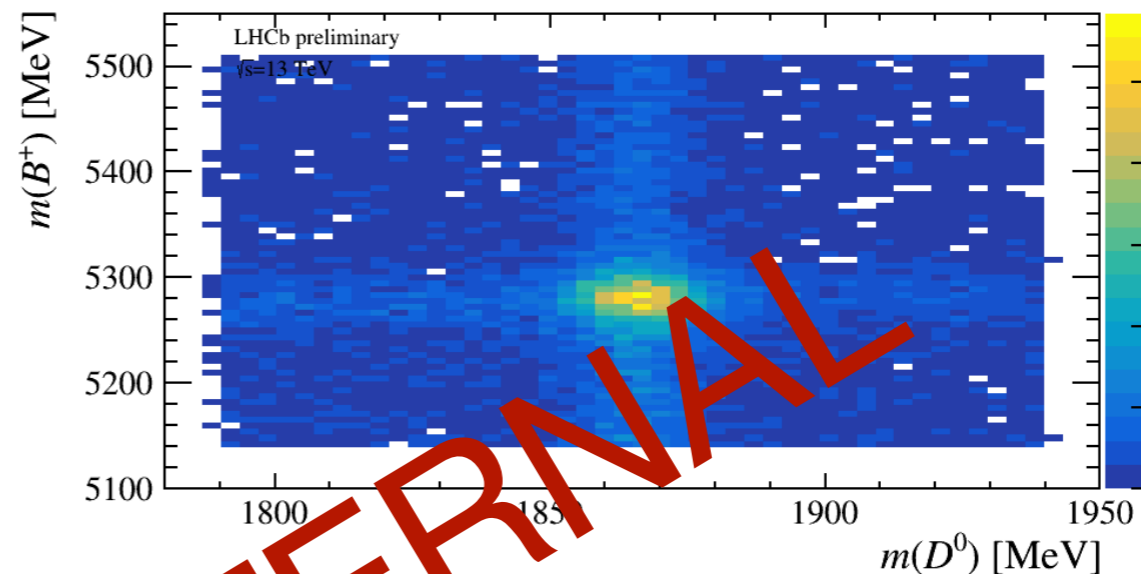
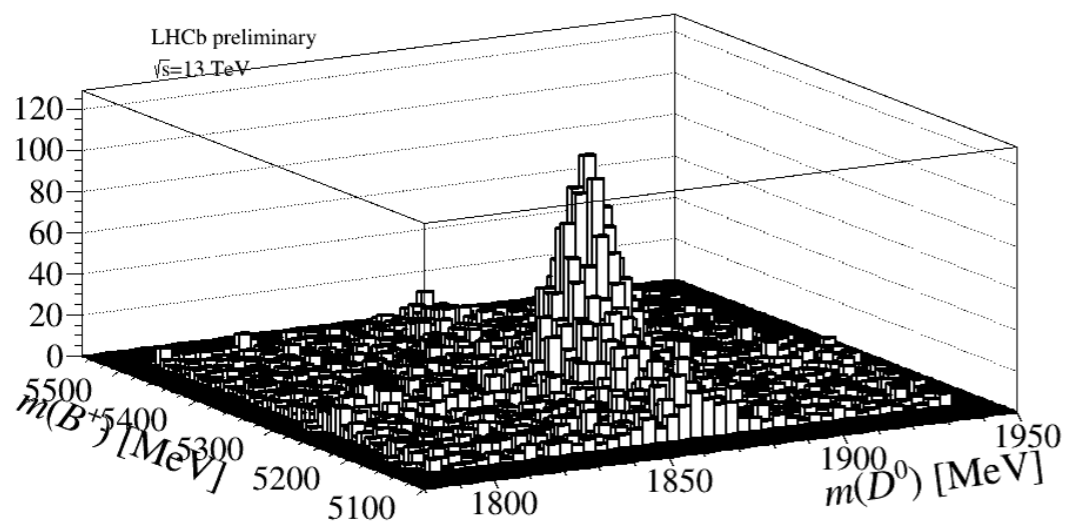
Kaon	meaning	B^+	meaning
$P_T > 200 \text{ MeV}$		$\chi^2_{vt}/ndf < 12$	
CLONEDIST >5000		$5.100 \text{ GeV} < M < 5.550 \text{ GeV}$ and $c\tau > 75 \mu\text{m}$	
TRGHOSTPROB <0.5			
TRCHI2DOF <4	$\chi^2_{track} < 4$		
$2 < \eta < 5$			
$3.2 \text{ GeV} < P < 150 \text{ GeV}$			
HASRICH			
MIPCHI2DV() >4	Minimum $\chi^2_{IP} > 4$		
PROBNNk >0.1			

Table 4: D^0 cuts in WGP

Kaon	Pion	D^0
$P_T > 250 \text{ MeV}$	same as Kaon	ADAMASS('D0') <85 MeV
CLONEDIST >5000		APT >0.95 GeV
TRGHOSTPROB <0.5		$\chi^2_{vtz} < 9$
$2 < \eta < 4.9$		$P_T > 1 \text{ GeV}$
$3.2 \text{ GeV} < P < 150 \text{ GeV}$		ADMAS('D0') <75MeV
HASRICH		$c\tau > 0.1 \text{ mm}$
MIPCHI2DV() >9		
PROBNNk >0.1	PROBNNpi >0.1	

[1] Working Group Production, 在官方DST基础上为不同分析组进一步筛选的数据

选择优化前



$Kp_ProbNNk > 0.3 \& Bu_log1mDIRA < -4.56 \&$
 $KmD_ProbNNk > 0.3 \& D0_log1mDIRA < -4.0$

选择优化后

