ATLAS Bc mini-workshop
6 February 2018

LHCb experimental overview of B_c^+

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Outline

Introduction

Searches for the new B_c^+-meson decays

- $B_c^+ \to J/\psi D^{(*)} K^{(*)}$
- $B_c^+ \to D^{0(*)} h^+$
- $B_c^+ \to D_{(s)}^{+(*)} D^{(*)}$

Test of the lepton universality with the semileptonic B_c^+ decays

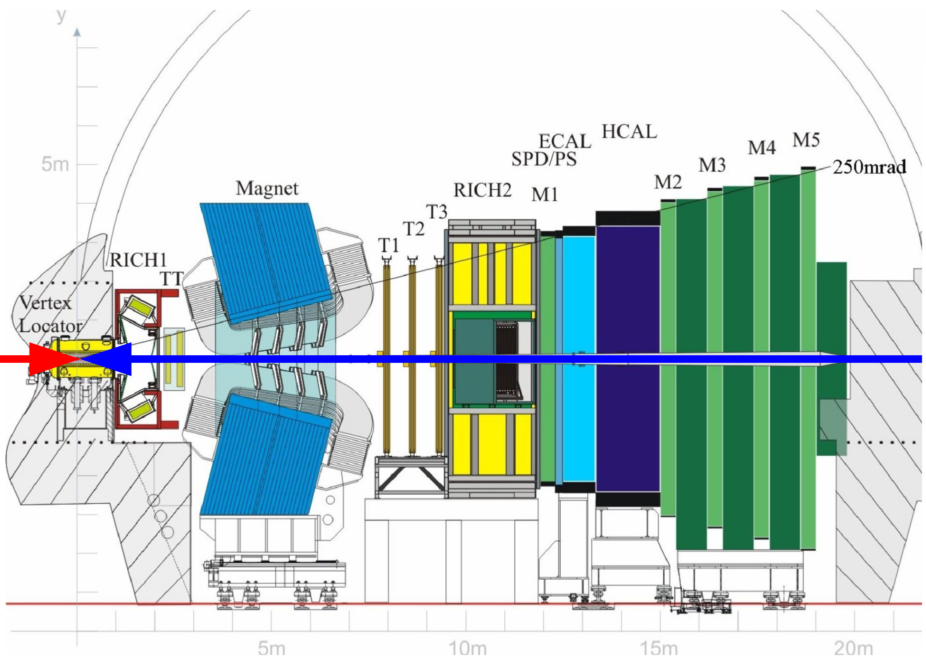
Searches for the excited B_c^+ states

B_c^+-mesons at LHCb

B_c^+-meson observed by the CDF collaboration in 1998 [Phys. Rev. Lett. 81, 2432]

Not accessible by the B-factories → least studied of all B-meson

Only 16 decay modes established by now



[JINST 3 (2008) S08005]

Fully instrumented rapidity range $2 < \eta < 5$

VELO: Decay time resolution ~45 fs for B-mesons
~100 fs for D-mesons

Relative track momentum resolution:
0.5% at low momentum 1.0% at 200 GeV/c

Particle identification:
Kaon ID ~95 % for ~ 5 % $\pi \to K$ mis-id probability
Muon ID ~97 % for 1-3 % $\pi \to \mu$ mis-id probability

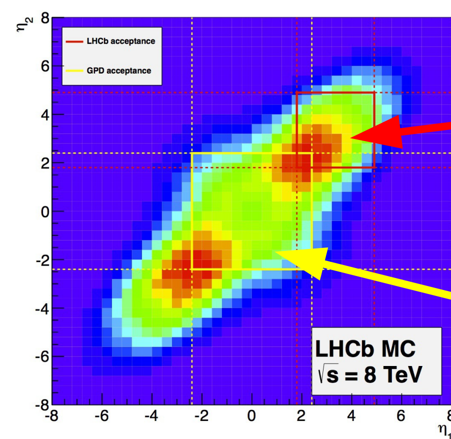
Trigger:
~90% trigger efficiency for dimuon channels
~30 % for multi-body hadronic final states

Production rates in the LHCb acceptance

$\sigma(B_c^+)$ ~ 20 nb @ 7 TeV

$\sigma(B_c^+)$ ~ 40 nb @14 TeV

[Phys.Atom.Nucl.60:1729-1740,1997]



LHCb region $2 < \eta < 5$

ATLAS and CMS region $|\eta| < 2.5$

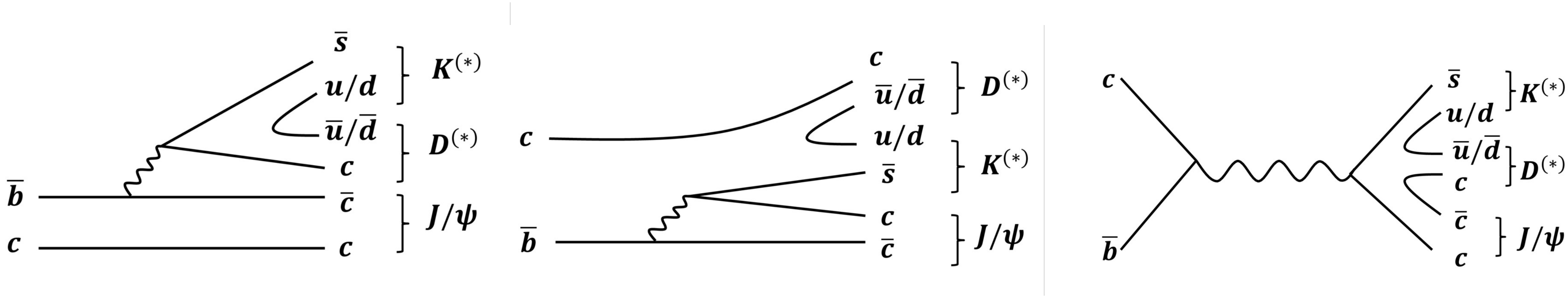
Searches for new B_c^+ decays

$B_c^+ \to J/\psi D^{(*)} K^{(*)}$

[Phys. Rev. D 95, 032005 (2017)]

Motivation

- Studying the DK system for the D_{SJ} contribution
- Opens the door to the possible exotic searches in $J/\psi D$ and close to DD threshold



Modes reconstructed

- $B_c^+ \to J/\psi(\to \mu^+\mu^-)D^0(\to K^-\pi^+\pi^-\pi^+)K^+$
- $B_c^+ \to J/\psi(\to \mu^+\mu^-)D^0(\to K^-\pi^+)K^+$
- Partially reconstructed $B_c^+ \to J/\psi(\to \mu^+\mu^-)D^{*0}(\to D^0 + \gamma/\pi^0)K^+$

- $B_c^+ \to J/\psi(\to \mu^+\mu^-)D^+(\to K^-\pi^+\pi^+)K^{*0}(\to K^+\pi^-)$
- Partially reconstructed $B_c^+ \to J/\psi(\to \mu^+\mu^-)D^{*+}(\to D^0\pi^+)K^{*0}(\to K^+\pi^-)$

$B_c^+ \to J/\psi D^{(*)} K^{(*)}$

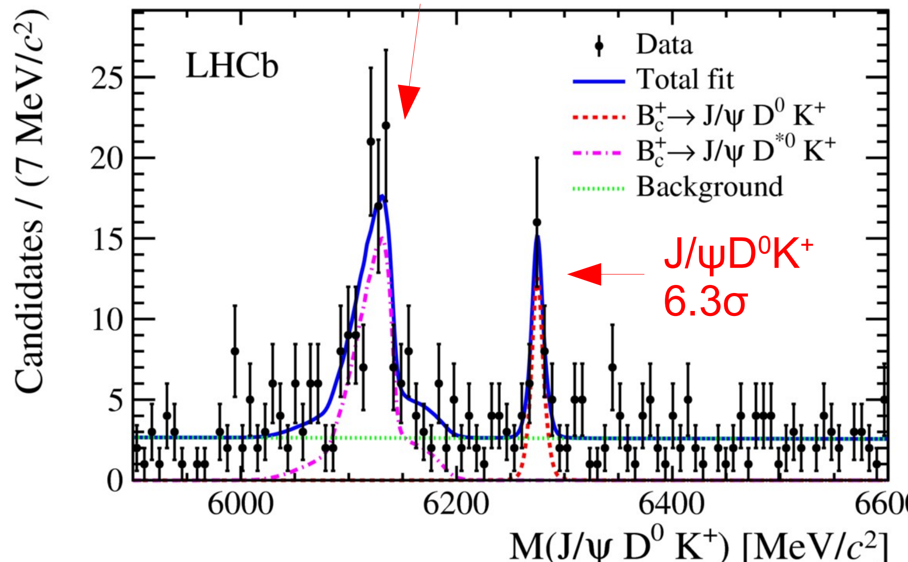
[Phys. Rev. D 95, 032005 (2017)]

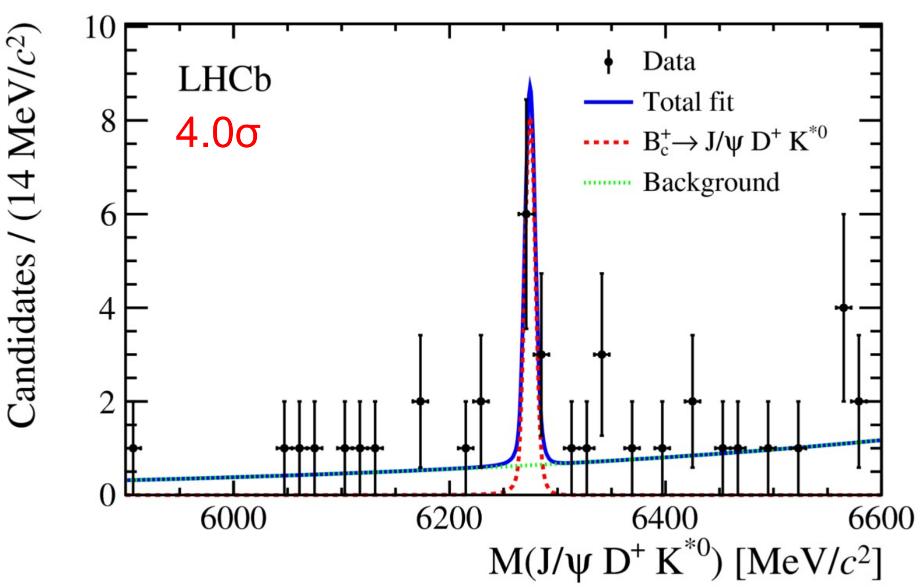
Data: 3 fb^{-1}, full Run 1 sample
Event selection: common loose preselection+BDT trained separately for each decay

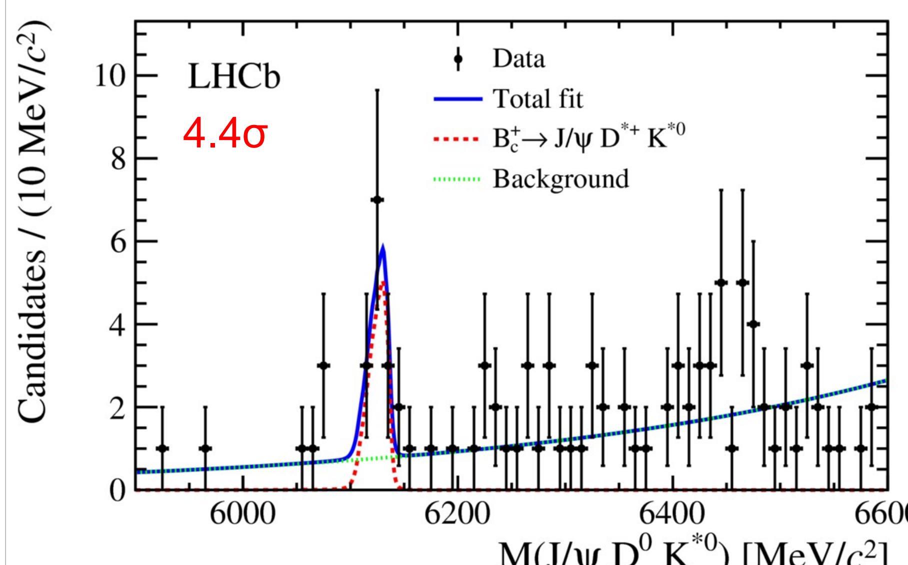
BDT based on
- B_c^+-meson transverse momentum
- χ^2 vertex fit for all unstable particles
- Event geometry

Similar selection for the normalization $B_c^+ \to J/\psi\pi^+$ channel

Partially reconstructed $B_c^+ \to J/\psi D^{0*} K^+$, 10.3σ







$B_c^+ \to J/\psi D^{(*)} K^{(*)}$

[Phys. Rev. D 95, 032005 (2017)]

Data: 3 fb^{-1}, full Run 1 sample

Event selection: common loose preselection+BDT trained separately for each decay

2 first observations and 2 first evidences:

$$\frac{\mathcal{B}(B_c^+ \to J/\psi\, D^0 K^+)}{\mathcal{B}(B_c^+ \to J/\psi\, \pi^+)} = 0.432 \pm 0.136 \pm 0.028,$$

$$\frac{\mathcal{B}(B_c^+ \to J/\psi\, D^{*0} K^+)}{\mathcal{B}(B_c^+ \to J/\psi\, D^0 K^+)} = 5.1 \pm 1.8 \pm 0.4,$$

$$\frac{\mathcal{B}(B_c^+ \to J/\psi\, D^{*+} K^{*0})}{\mathcal{B}(B_c^+ \to J/\psi\, D^0 K^+)} = 2.10 \pm 1.08 \pm 0.34,$$

$$\frac{\mathcal{B}(B_c^+ \to J/\psi\, D^{+} K^{*0})}{\mathcal{B}(B_c^+ \to J/\psi\, D^0 K^+)} = 0.63 \pm 0.39 \pm 0.08,$$

Most precise single mass measurement:

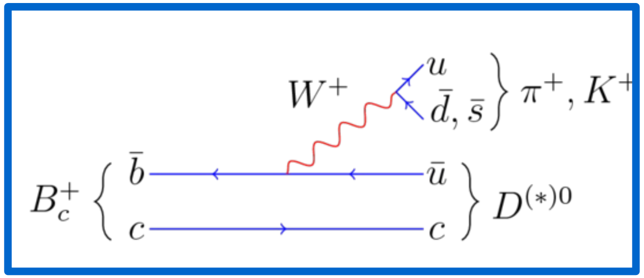
$M(B_c^+) = 6274.28 \pm 1.40 \pm 0.32$ MeV/c^2

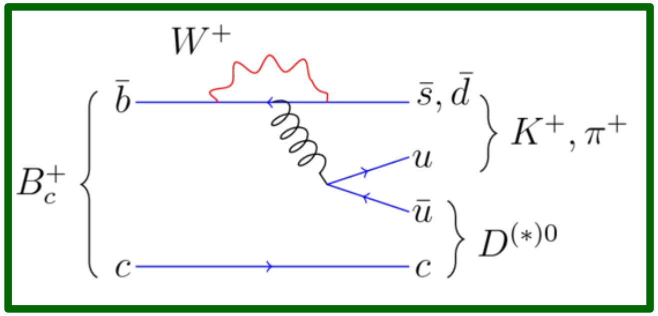
Consistent with previous LHCb measurements and the world average

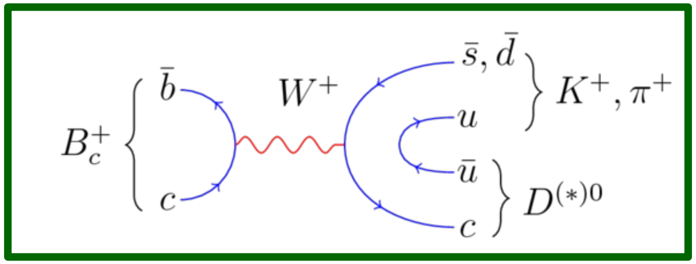
$B_c^+ \to D^{0(*)}h^+$

Cabbibo-suppressed with respect to $B_c^+ \to J/\psi\pi$

[Phys. Rev. Lett 118, 111803 (2017)]







May enhance the branching fraction

Theoretical predictions vary in a large range

1.3×10^{-7} to 6.6×10^{-5} for $B_c^+ \to D^0K^+$

2.3×10^{-7} to 2.3×10^{-6} for $B_c^+ \to D^0\pi^+$ [JHEP 1106 (2011) 015], [Eur.Phys.J.C63 (2009) 435] [Eur.Phys.J.C5 (1998) 705]

Modes under study (h = K, π):

$B_c^+ \to D^0(\to K^-\pi^+\pi^-\pi^+)h^+$

$B_c^+ \to D^0(\to K^-\pi^+)h^+$

Partially reconstructed $B_c^+ \to D^{*0}(\to D^0+\gamma/\pi^0)h^+$

Measure ratios for all four modes normilizing by the known $B^+ \to \overline{D}h^+$ decay

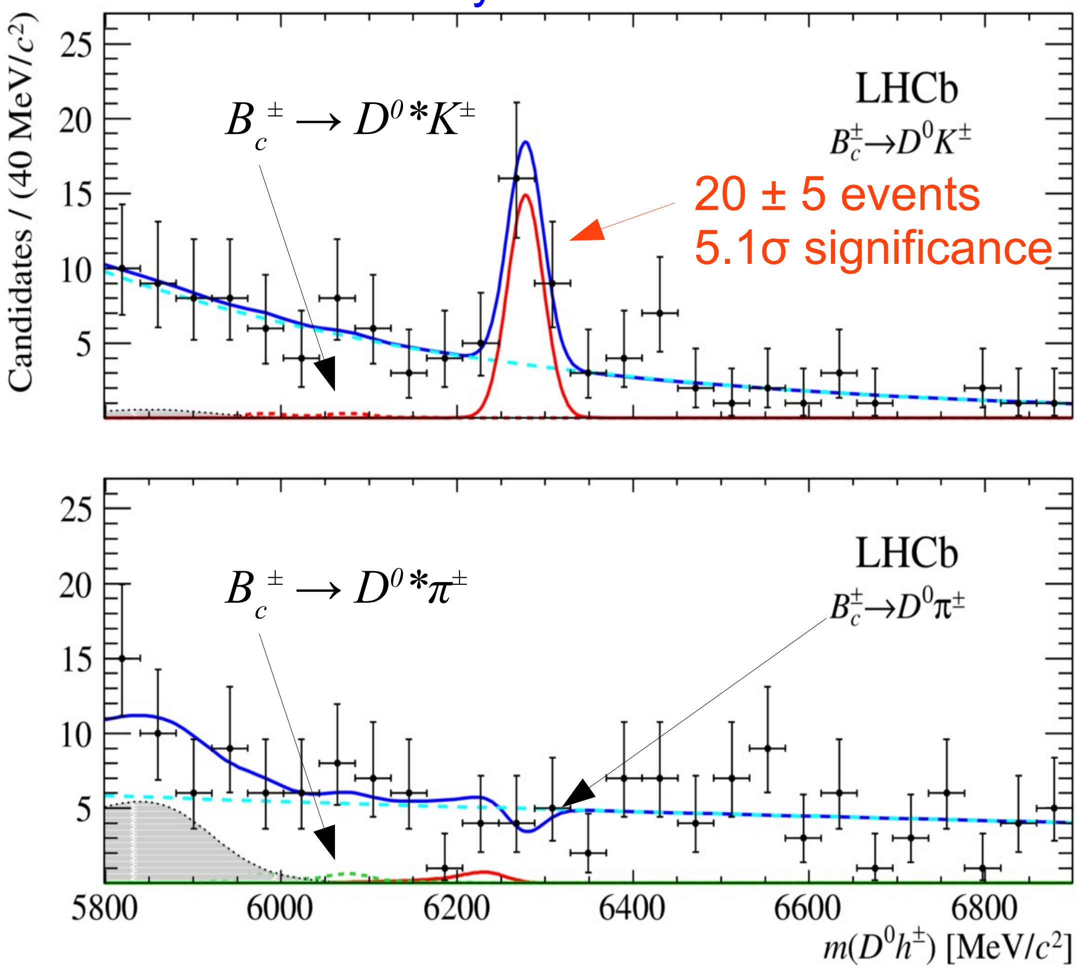
$$R_{D^{(*)0}h} = \frac{f_c}{f_u} \times \mathcal{B}(B_c^+ \to D^{(*)0}h^+)$$

$B_c^+ \to D^{0(*)}h^+$

[Phys. Rev. Lett 118, 111803 (2017)]

Data: 3 fb^{-1}, full Run 1 sample
Event selection: loose preselection + 2 BDT trained to remove D^0 and non-D^0 background

Simultaneous fit to 2 decay modes
2- and 4-body D^0 modes combined



For fully reconstructed decays:
- B_c^+ masses fixed to the PDG values
- Resolutions are estimated from the normalization channel $B^+ \to \bar{D}h^+$

First observation of the $B_c^\pm \to D^0K^\pm$ decay
- Branching fraction measured

$$R_{D^{(*)0}h} = \frac{f_c}{f_u} \times \mathcal{B}(B_c^+ \to D^{(*)0}h^+) = (9.3\,^{+2.8}_{-2.5} \pm 0.6) \times 10^{-7}$$

At the high end of theoretical predictions
Absence of $B_c^\pm \to D^0\pi^\pm$ means that the tree-level contribution is not dominating one

For the other modes the upper limits are set up @95% CL

$$R_{D^0\pi} < 3.9 \times 10^{-7}$$
$$R_{D^{*0}\pi} < 1.1 \times 10^{-6}$$
$$R_{D^{*0}K} < 1.1 \times 10^{-6}.$$

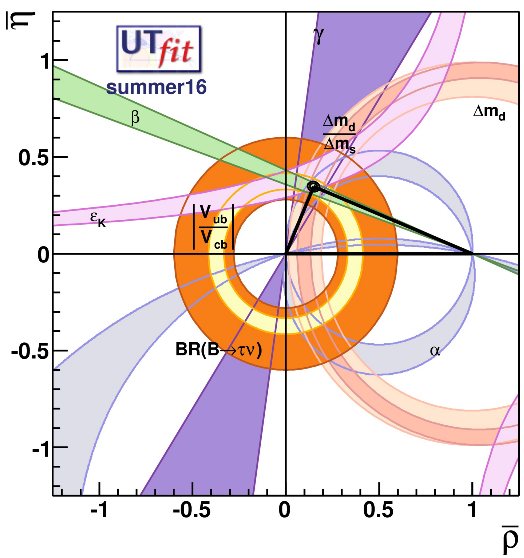
Decays into two charmed mesons

[arXiv:1712.04702, submitted to Nucl.Phys.B]

Motivation

Additional possibilities for the Unitarity Triangle angle γ measurements

$$\gamma \equiv \arg(-V_{ud}V_{ub}^*/V_{cd}V_{cb}^*)$$



Lower production cross-section than for B^+-mesons

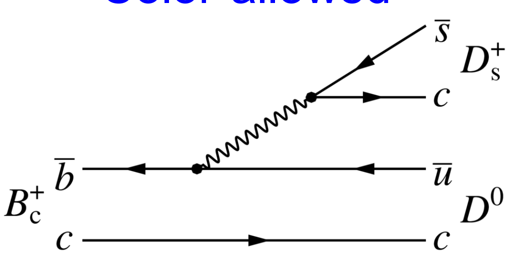
Lower branching fractions than for $B^+ \to DK$

Channel	Prediction for the branching fraction $[10^{-6}]$			
$B_c^+ \to D_s^+ \overline{D}^0$	2.3 ± 0.5	4.8	1.7	2.1
$B_c^+ \to D_s^+ D^0$	3.0 ± 0.5	6.6	2.5	7.4
$B_c^+ \to D^+ \overline{D}^0$	32 ± 7	53	32	33
$B_c^+ \to D^+ D^0$	0.10 ± 0.02	0.32	0.11	0.32

[Phys. Rev. D86 (2012) 074019], [arXiv:hep-ph/0211021], [Phys. Lett. B555 (2003) 189], [Phys. Rev. D73 (2006) 054024]

Expected large amplitude ratio and CP-asymmetry

Color-allowed



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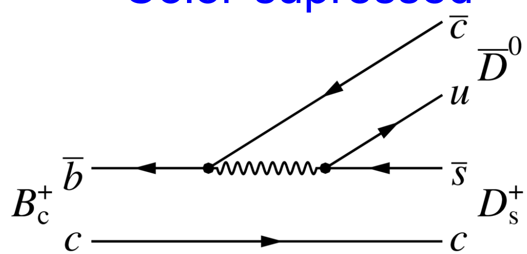


$$r_{B_c^+} \equiv |A(B_c^+ \to D^0 D_s^+)/A(B_c^+ \to \overline{D}^0 D_s^+)| \approx 1$$

[Phys.Rev. D62 (2000) 057503]

Can use decays with excited D-mesons in the final state also

Alternative method: study of the angular distributions in $B_c^+ \to D_{(s)}^{*+} D^*$

[Phys. Rev. D65 (2002) 034016]

Decays into two charmed mesons

[arXiv:1712.04702, submitted to Nucl.Phys.B]

Data: 3 fb^{-1}, full Run 1 sample

Decay modes reconstructed:

$B_c^+ \to D^+_{(s)}\ D$

$B_c^+ \to D^{*+}_{(s)}\ D$

$B_c^+ \to D^+_{(s)}\ D^*$

$B_c^+ \to D^{*+}_{(s)} D^*$

Weighted sum of branching fractions is measured

Where D = D^0, $\overline{D}^0$

No signals observed for any of the decay modes

The upper limits are set @90%(95%) CL:

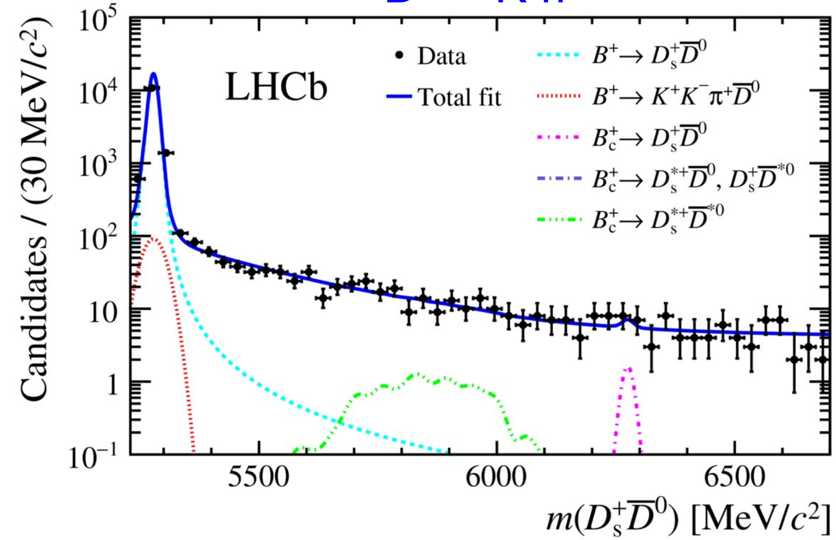
$$\frac{f_c}{f_u}\frac{\mathcal{B}(B_c^+\to D_s^+\overline{D}^0)}{\mathcal{B}(B^+\to D_s^+\overline{D}^0)} = (\ \ 3.0\pm3.7)\times10^{-4}\ [<0.9\,(1.1)\times10^{-3}],$$

$$\frac{f_c}{f_u}\frac{\mathcal{B}(B_c^+\to D_s^+ D^0)}{\mathcal{B}(B^+\to D_s^+\overline{D}^0)} = (-3.8\pm2.6)\times10^{-4}\ [<3.7\,(4.7)\times10^{-4}],$$

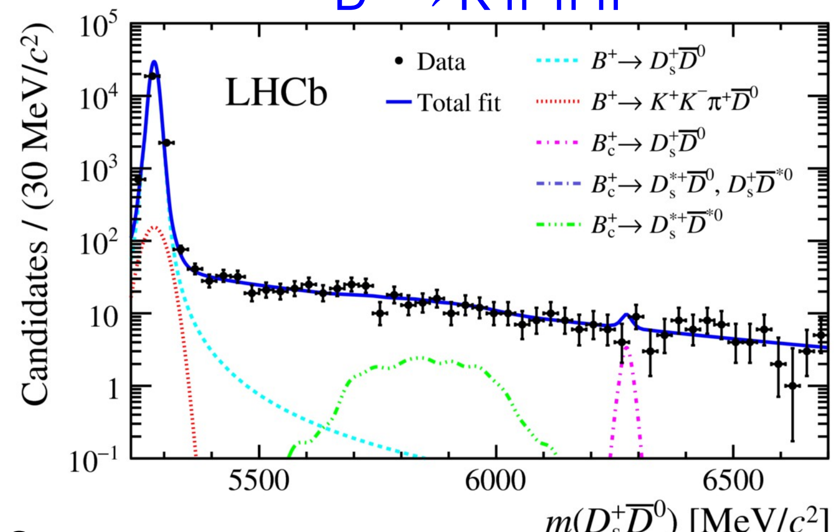
$$\frac{f_c}{f_u}\frac{\mathcal{B}(B_c^+\to D^+\overline{D}^0)}{\mathcal{B}(B^+\to D^+\overline{D}^0)} = (\ \ 8.0\pm7.5)\times10^{-3}\ [<1.9\,(2.2)\times10^{-2}],$$

$$\frac{f_c}{f_u}\frac{\mathcal{B}(B_c^+\to D^+ D^0)}{\mathcal{B}(B^+\to D^+\overline{D}^0)} = (\ \ 2.9\pm5.3)\times10^{-3}\ [<1.2\,(1.4)\times10^{-2}].$$

$D^0 \to K^-\pi^+$



$D^0 \to K^-\pi^+\pi^-\pi^+$



And also for the modes involving excited D-mesons

Upper limits are far above the theoretical predictions

Lepton universality with semileptonic B_c^+ decays

Lepton universality

Lepton universality: SM predicts same behavior for all charged leptons

Same amplitudes besides the effects of different masses

Difference in amplitudes may be caused by non-standard contributions:

charged Higgs, leptoquarks, new vector bosons

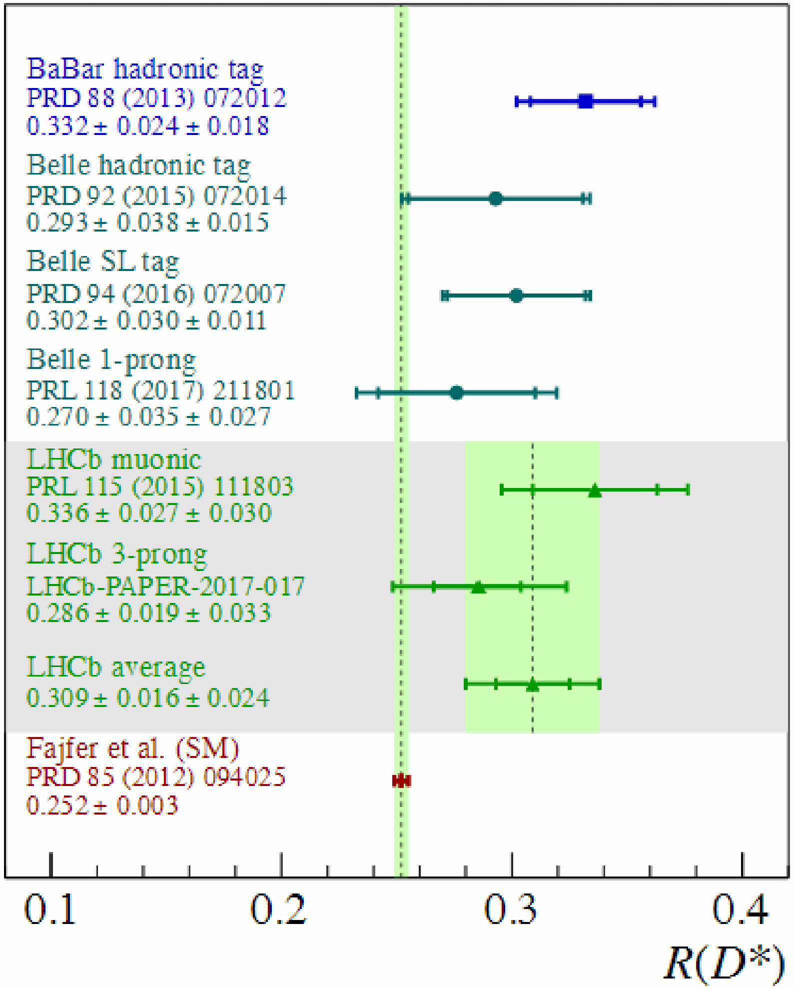
Some recent results give a hint of deviation from the SM predictions

$B^+ \to K^+ l^+ l^-$ [Phys.Rev.Lett. 113 (2014) 151601]

$B^0 \to K^{*0} l^+ l^-$ [JHEP 08 (2017) 055]

$R(D^*) = Br(B \to D^{(*)}\tau\nu_\tau)/Br(B \to D^{(*)}\mu\nu_\mu)$

by BaBar, Belle and LHCb



Semileptonic decays are a good tool for such studies

simple theoretical descriptions through tree-level diagrams in SM

new channels should give additional information

Semileptonic B_c^+ decays

[arXiv:1711.05623, submitted to PRL]

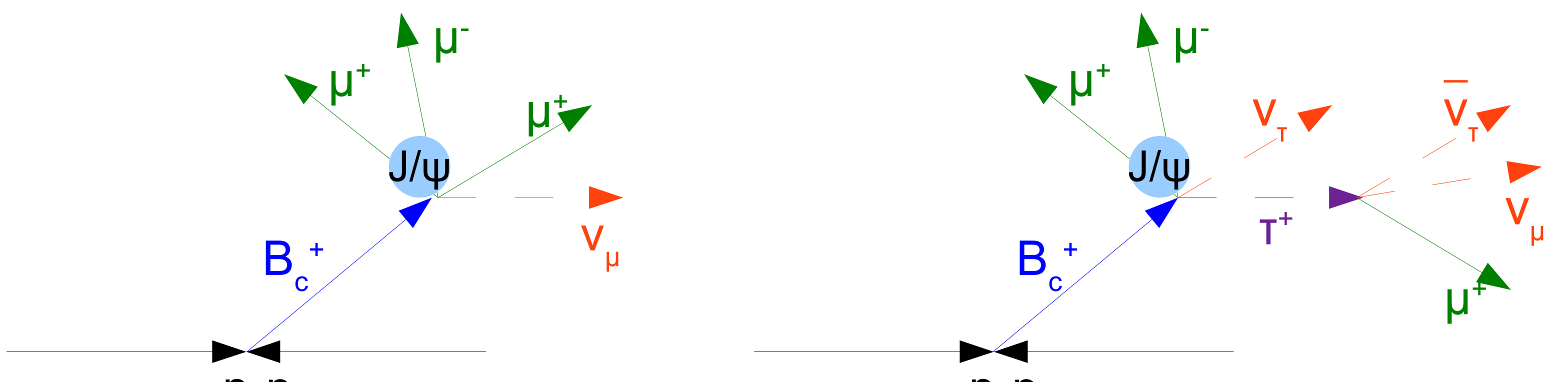
Possibility provided by the B_c^+ decays:

$$\mathcal{R}(J/\psi) = \frac{\mathcal{B}(B_c^+ \to J/\psi\,\tau^+\nu_\tau)}{\mathcal{B}(B_c^+ \to J/\psi\,\mu^+\nu_\mu)}$$

SM expectation ~0.25-0.28 depending on form-factors

[Phys. Lett. B452 (1999) 129] [arXiv:hep-ph/0211021]
[Phys. Rev. D73 (2006) 054024] [Phys. Rev. D74 (2006) 074008]

Data: 3 fb^{-1}, full Run 1 sample
Event selection: cut-based + isolation BDT, same for both semimuonic and semitauonic channels



Disentangle semimuonic and semitauonic contributions via different decay kinematics based on three variables:

- Missing mass: $m^2_{miss} = (\mathbf{p}_{Bc} - \mathbf{p}_{J/\psi} - \mathbf{p}_{\mu})^2$
- Energy of the bachelor muon: E_μ^*
- Four-momentum transfer: $q^2 = (\mathbf{p}_{Bc} - \mathbf{p}_{J/\psi})^2$

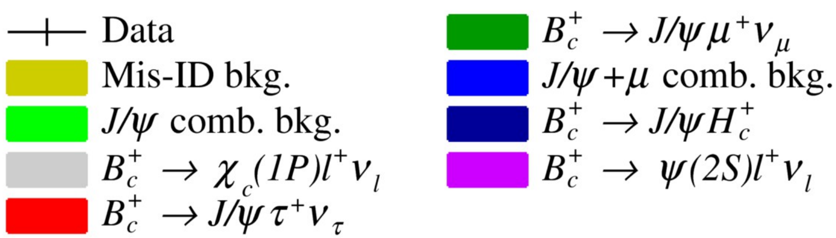
  $\left.\begin{matrix} E_\mu^* \\ q^2 \end{matrix}\right\} Z(q^2, E_\mu^*)$
- B_c^+-meson decay time – to remove background from light B-mesons decays

B-meson direction of flight determined as the direction from primary to secondary vertex and $(p_B)_z = \frac{m_B}{m_{\rm reco}}(p_{\rm reco})_z$

Results

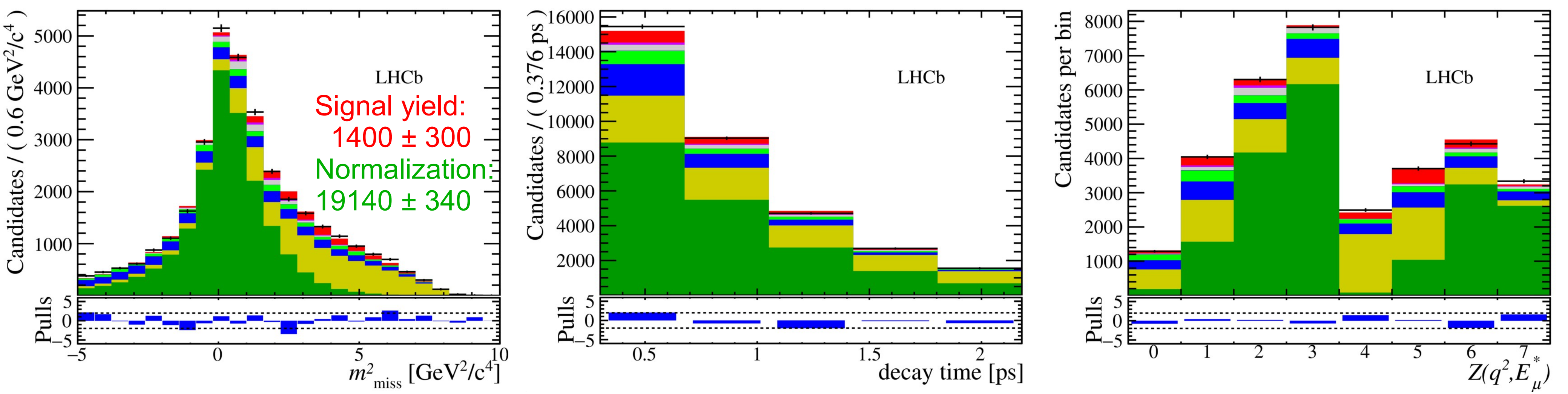
[arXiv:1711.05623, submitted to PRL]

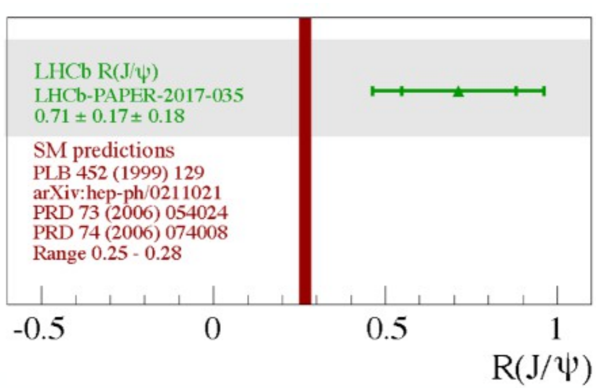
Data: 3 fb^{-1}, full Run 1 sample
Event selection: cut-based, same for both semimuonic and semitauonic channels



Binned maximum likelihood fit with templates

- Signals templates from the simulation with form-factors determined from data
- Background templates determined from simulation





Ratio of branching fractions measured

$$\mathcal{R}(J/\psi) = \frac{\mathcal{B}(B_c^+ \to J/\psi\, \tau^+ \nu_\tau)}{\mathcal{B}(B_c^+ \to J/\psi\, \mu^+ \nu_\mu)} = 0.71 \pm 0.17\,(\mathrm{stat}) \pm 0.18\,(\mathrm{syst})$$

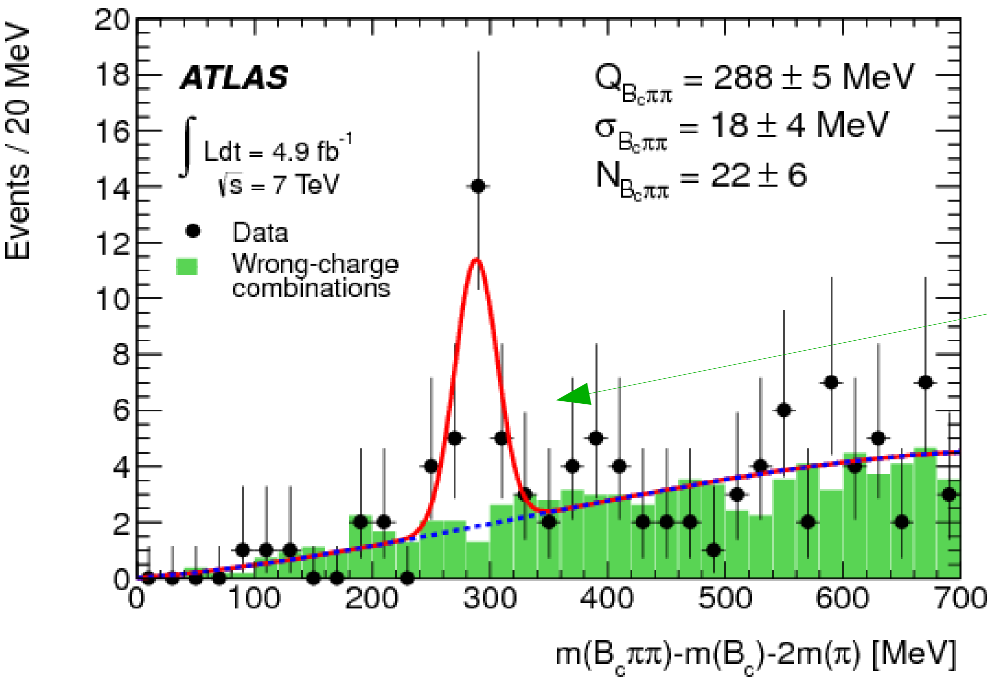
Within 2σ with the theoretical predictions

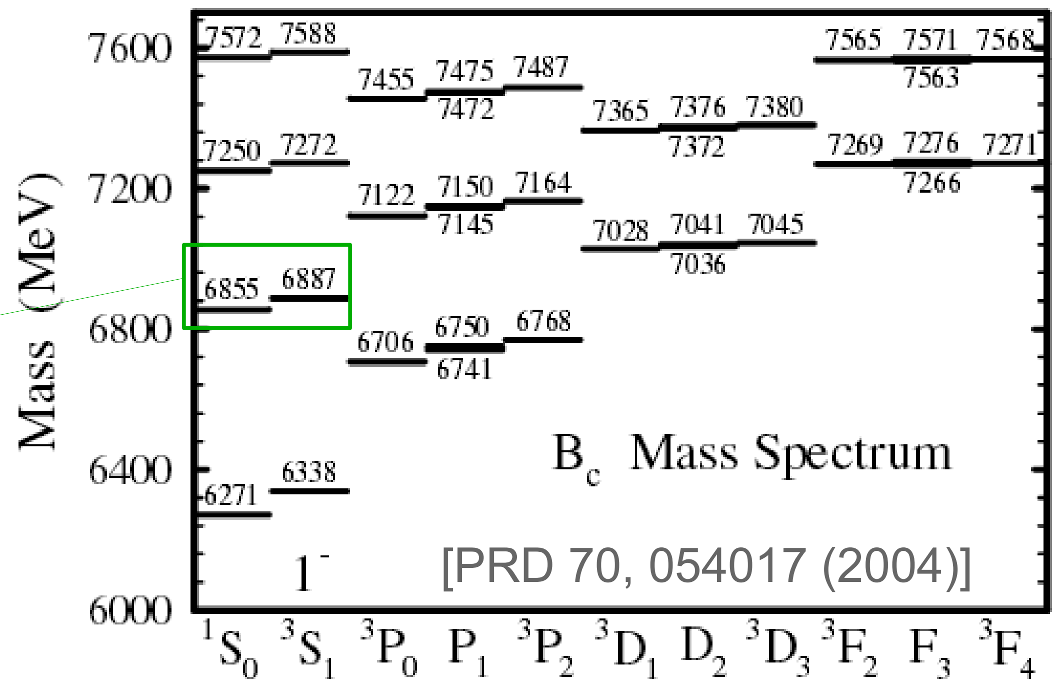
- Still higher than the SM prediction as well as R(D*)

B_c^+ *spectroscopy*

Excited states

B_c^+ has a large spectrum, the excited states still remain to be observed





Many theoretical predictions for spectroscopy and properties.

[arxiv:9703341], [PRD 71, 074012].

First $B_c(2S)^+$ observation was recently claimed by ATLAS

$B_c^+\pi^+\pi^-$ final state

Measured mass 6842 ± 4 ± 5 MeV/c^2

[Phys. Rev. Lett. 113, 212004 (2014)]

The most probable interpretation is either $B_c(2^3S_1)$ or sum of $B_c(2^3S_1)$ and $B_c(2^1S_0)$

Search for excited B_c^+ states

[arXiv:1712.04094, accepted by JHEP]

Data: 2 fb^{-1} collected in pp collisions at the energy of $\sqrt{s}$ = 8 TeV

Search for $B_c(2^1S_0)$ and $B_c(2^3S_1)$ states

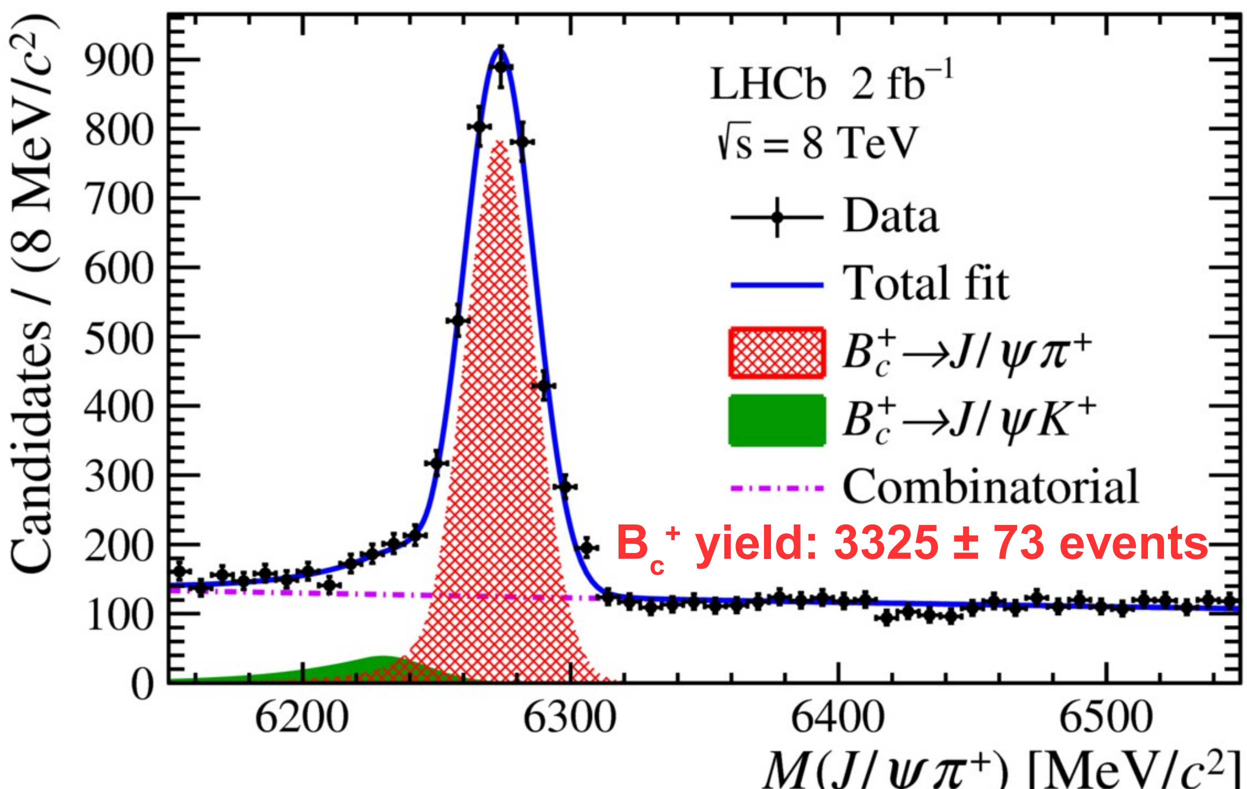
$B_c(2^1S_0) \rightarrow B_c^+ (\rightarrow J/\psi\pi^+)\ \pi^+\pi^-$

$B_c(2^3S_1) \rightarrow B_c^*(\rightarrow B_c^+ (\rightarrow J/\psi\pi^+)\gamma)\ \pi^+\pi^-$ with missing photon

In the transverse momentum range of $p_T \in [0, 20]$ GeV/c and rapidity $y \in [2.0, 4.5]$

Use BDT for the $B_c^+ \rightarrow J/\psi\pi^+$ selection

BDT based on the vertex χ^2, impact parameters χ^2 with respect to primary vertex and transverse momenta of the daughter particles

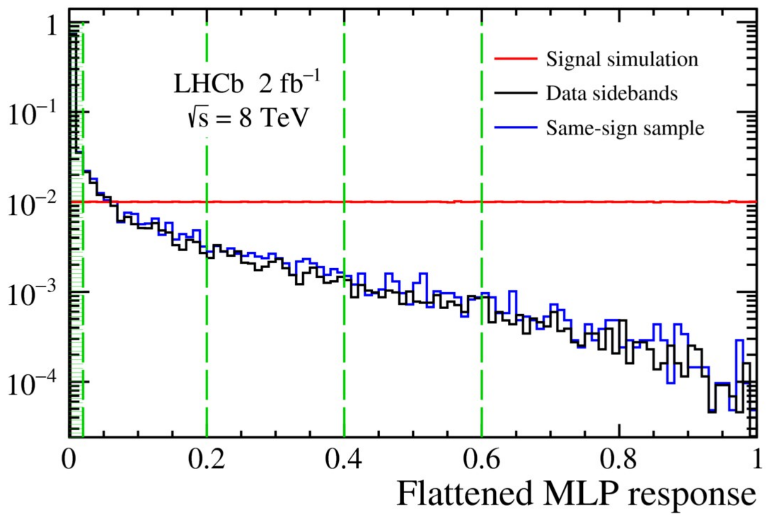


Search for excited B_c^+ states

[arXiv:1712.04094, accepted by JHEP]

Apply MLP for further selection of $B_c(2S)$ to improve the sensitivity

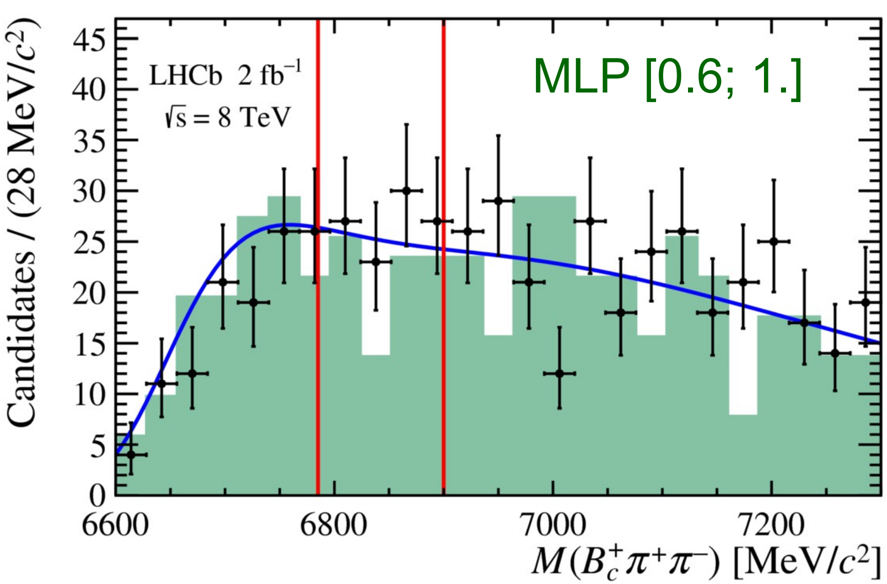
MLP based on the angular variables between the B_c^+ and B_c^{*+} daughter particles



Total selection efficiencies for the $B_c(2^1S_0)$ and $B_c(2^3S_1)$ in the four MLP bins

MLP category	(0.02, 0.2)	[0.2, 0.4)	[0.4, 0.6)	[0.6, 1.0]
	Efficiencies in %			
$B_c(2S)^+$	0.148 ± 0.006	0.140 ± 0.006	0.130 ± 0.006	0.256 ± 0.008
$B_c^*(2S)^+$	0.118 ± 0.003	0.140 ± 0.004	0.144 ± 0.004	0.288 ± 0.005

No significant signal in the $B_c^+\pi^+\pi^-$ invariant mass is seen



\+ - data

- same-sign background

- considered signal region

Upper limits set up for the ratio:

$$\mathcal{R} = \frac{\sigma_{B_c^{(*)+}(2S)}}{\sigma_{B_c^+}} \cdot \mathcal{B}_{B_c^{(*)+}(2S) \to B_c^{(*)+}\pi^+\pi^-}$$

With the help of CL_s method

Search for excited B_c^+ states

[arXiv:1712.04094, accepted by JHEP]

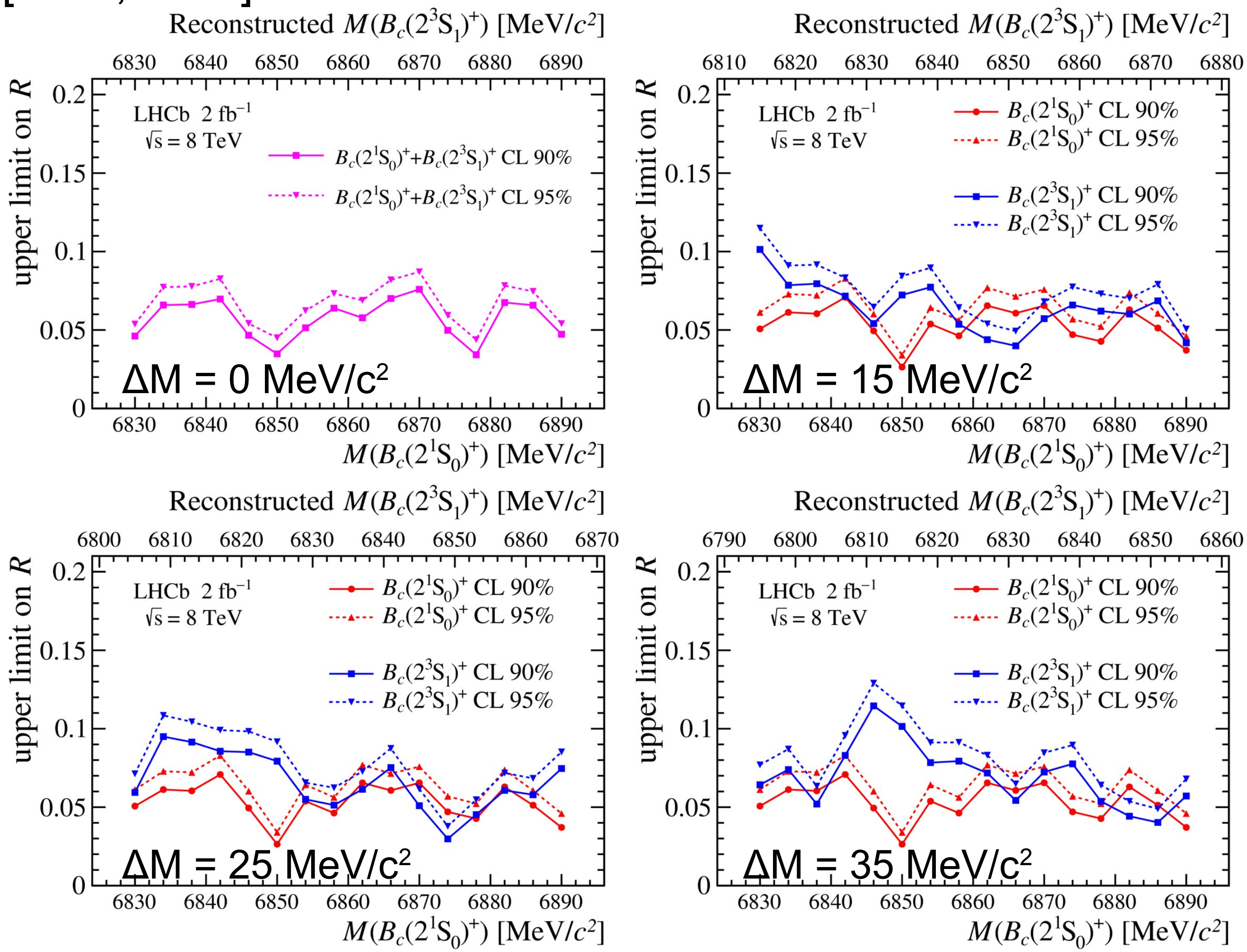
Mass resolution fixed from simulation, cross-checked with data for $B_c^+ \rightarrow J/\psi\pi^+\pi^+\pi^-$

4 different values of reconstructed mass difference (ΔM) between $B_c(2^1S_0)$ and $B_c(2^3S_1)$

Scan over the signal mass range

- $B_c(2^1S_0)$: [6830, 6890] MeV/c^2
- $B_c(2^3S_1)$: [6795, 6890] MeV/c^2

Consistent with background-only hypothesis within 3σ

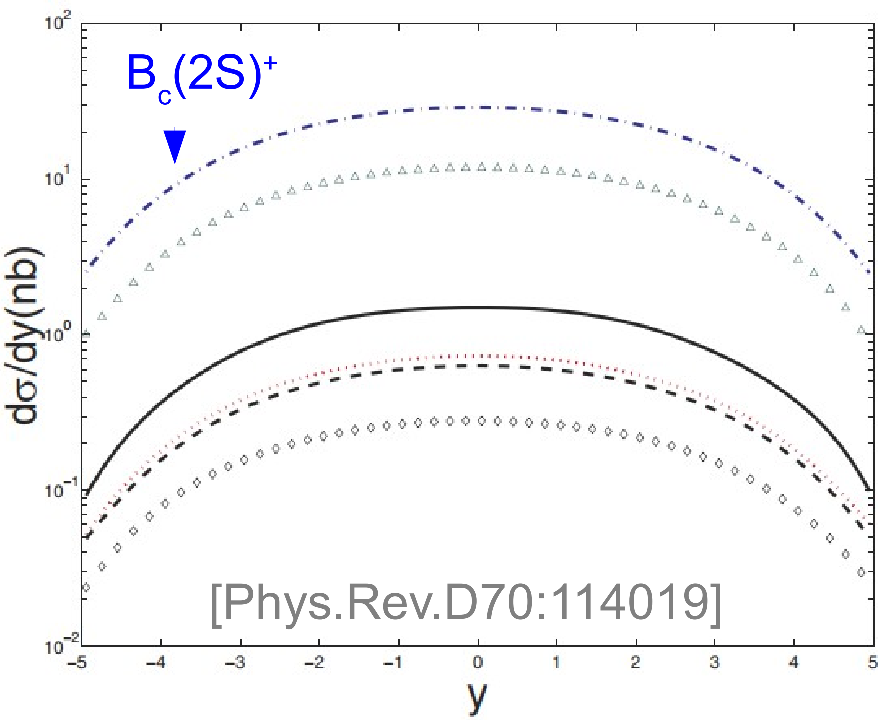


Search for excited B_c^+ states

[arXiv:1712.04094, accepted by JHEP]

Resulting upper limits are contained in the range [0.04; 0.09]

Consistent with most theoretical predictions



ATLAS efficiencies should be large to achieve consistency

	$\sqrt{s} = 7\,\text{TeV}$	$\sqrt{s} = 8\,\text{TeV}$
ATLAS	$(0.22 \pm 0.08\,(\text{stat}))/\varepsilon_7$	$(0.15 \pm 0.06\,(\text{stat}))/\varepsilon_8$
LHCb	–	$<[0.04, 0.09]$

$\varepsilon_{7,8}$ – relative efficienties of reconstructing $B_c(2S)$ with respect to B_c^+ signals

For $Br(B_c(2S)^+ \to B_c^+\pi^+\pi^-) = 49\%$

$Br(B_c^*(2S) \to (B_c^*(\to B_c^+\gamma)\pi^+\pi^-) = 39\%$

[arXiv:hep-ph/0211432]

	$R_{Bc(2S)+}$	$R_{Bc^*(2S)+}$
BcVegPy hep-ph/9602347	0.02	0.04
Fragmentation approach arXiv:hep-ph/0211432	0.02	0.04
Complete order-α_s^4 Chin. Phys. Lett. 27 061302	0.04	0.09

For $Br(B_c(2S)^+ \to B_c^+\pi^+\pi^-) = 59\%$

$Br(B_c^*(2S) \to (B_c^*(\to B_c^+\gamma)\pi^+\pi^-) = 53\%$

[Phys. Rev. D70 (2004) 054017]

	$R_{Bc(2S)+}$	$R_{Bc^*(2S)+}$
BcVegPy hep-ph/9602347	0.02	0.05
Complete order-α_s^4 Chin. Phys. Lett. 27 061302	0.05	0.12

Conclusions

A number of new decays of B_c^+-mesons are observed and studied

- Most precise B_c^+ mass measurement in a single decay
- Observation of penguin and/or weak annihilation decays of the B_c^+-mesons
- Open up exciting possibilities for the future studies

A test of the lepton universality performed with the help of the semileptonic B_c^+-mesons decays

- Within 2 standard deviations agreement with the SM
- Higher than the SM prediction as well as R(D*)

Searches for the excited B_c^+ states performed

- No signals observed for the $B_c(2^1S_0)$ and $B_c(2^3S_1)$ states

Work in progress... Looking forward for the new results!

Backup

Previous LHCb B_c^+ studies

Properties:

- Measurement of the lifetime of the B_c^+ meson using the $B_c^+ \to J/\psi\pi^+$ decay mode
  Phys. Lett. B 742 (2015) 29-37
- Measurement of the B_c^+ meson lifetime using $B_c^+ \to J/\psi\mu^+\nu_\mu X$ decays
  Eur. Phys. J. C74 (2014) 2839
- Measurements of B_c^+ production and mass with the $B_c^+ \to J/\psi\pi^+$ decay
  Phys. Rev. Lett. 109, 232001 (2012)

New decays:

- Study of B_c^+ decays to the $K^+K^-\pi^+$ final state and evidence for the decay $B_c^+ \to \chi_{c0}\pi^+$
  Phys. Rev. D 94, 091102 (2016)
- Search for B_c^+ decays to the $p\bar{p}\pi^+$ final state, Physics Letter B759, 313 (2016)
- First observation of a baryonic B_c^+ decay, Phys. Rev. Lett. 113, 152003 (2014)
- Evidence for the decay $B_c^+ \to J/\psi 3\pi^+ 2\pi^-$, JHEP 1405 (2014) 148
- Observation of the decay $B_c^+ \to J/\psi K^+K^-\pi^+$, JHEP 1311 (2013) 094
- Observation of the decay $B_c^+ \to B^0_s\pi^+$, Phys. Rev. Lett. 111, 181801 (2013)

Previous LHCb B_c^+ studies

New decays

- First observation of the decay $B_c^+ \to J/\psi K^+$, JHEP09(2013)075
- Observation of $B_c^+ \to J/\psi D^+_s$ and $B_c^+ \to J/\psi D^{*+}_s$ decays, Phys.Rev.D87, 11 (2013) 112012
- Observation of the decay $B_c^+ \to \psi(2S)\pi^+$, Phys. Rev. D 87, 071103(R) (2013)
- First observation of decay $B_c^+ \to J/\psi\pi^+\pi^-\pi^+$, Phys. Rev. Lett. 108, 251802 (2012)

Branching fractions

- Measurement of the ratio of branching fractions $B(B_c^+ \to J/\psi K^+)/B(B_c^+ \to J/\psi\pi^+)$ JHEP 1609 (2016) 153
- Measurement of the branching fraction ratio $B(B_c^+ \to \psi(2S)\pi^+)/B(B_c^+ \to J/\psi\pi^+)$ Phys. Rev. D 92, 072007 (2015)
- Measurement of the ratio of B_c^+ branching fractions to $J/\psi\pi^+$ and $J/\psi\mu^+\nu_\mu$ final states Phys. Rev. D 90, 032009 (2014)

Full list of the LHCb measurements:
http://lhcbproject.web.cern.ch/lhcbproject/Publications/LHCbProjectPublic/Summary_all.html

Excited B_c^+ mesons simulation and selection

Pythia 6 + BcVegPy

- $M(B_c(2S)^+)$ = 6858 MeV/c^2
- $M(B^*_c(2S)^+)$ = 6890 MeV/c^2
- $M(B^{*+}_c)$ = 6342 MeV/c^2
- ΔM = 35 MeV/c^2
- Unpolarized $B^*_c(2S)^+$

B^+_c preselection

- Muon p_T > 0.55 GeV/c
- $M(J/\psi)$ in [3.04; 3.14] GeV/c^2
- Pion p_T > 1.00 GeV/c
- Pion impact parameter χ^2 with respect to primary vertex (χ^2_{IP}) > 9
- B^+_c decay time > 0.2 ps
- $\chi^2_{IP}(B^+_c) < 25$

MLP variables

- Angles between the B^+_c and π^+, B^+_c and π^-, π^+ and π^- candidate momenta projected in the plane transverse to the beam axis
- Angles between the $B^{(*)}_c(2S)^+$ momentum and the B^+_c, π^+, and π^- momenta in the $B^{(*)}_c(2S)^+$ centre-of-mass frame
- Minimum cosine value of the angles between the momentum of the B^+_c meson or of one of the pions from $B^{(*)}_c(2S)^+$ and the momentum of the muons or pion from the B^+_c meson
- The vertex-fit χ^2 of the $B^{(*)}_c(2S)^+$ meson.

Isolation BDT for semileptonic decays

Input variables:

- Transverse momentum of the track
- Impact parameter χ^2 of the track with respect to the primary vertex
- Impact parameter χ^2 of the track with respect to the B+c vertex
- The cosine of the angle track makes with J/ψμ momentum
- Flight distance χ^2 of the B^+_c before and after the addition of the track

Search for excited B_c^+ states

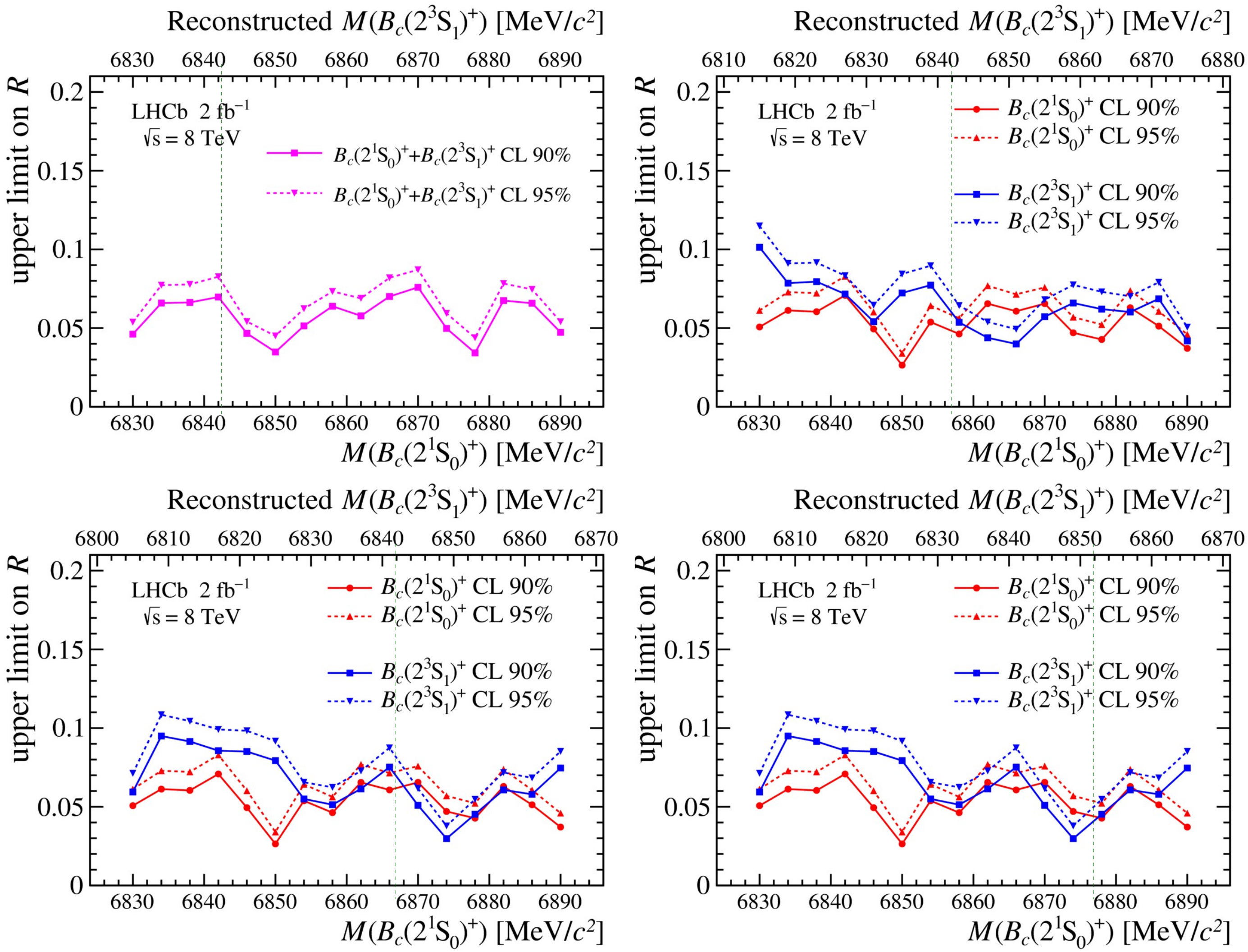
[arXiv:1712.04094, accepted by JHEP]

Mass resolution fixed from simulation, cross-checked with data for $B_c \to J/\psi \pi^+\pi^+\pi^-$

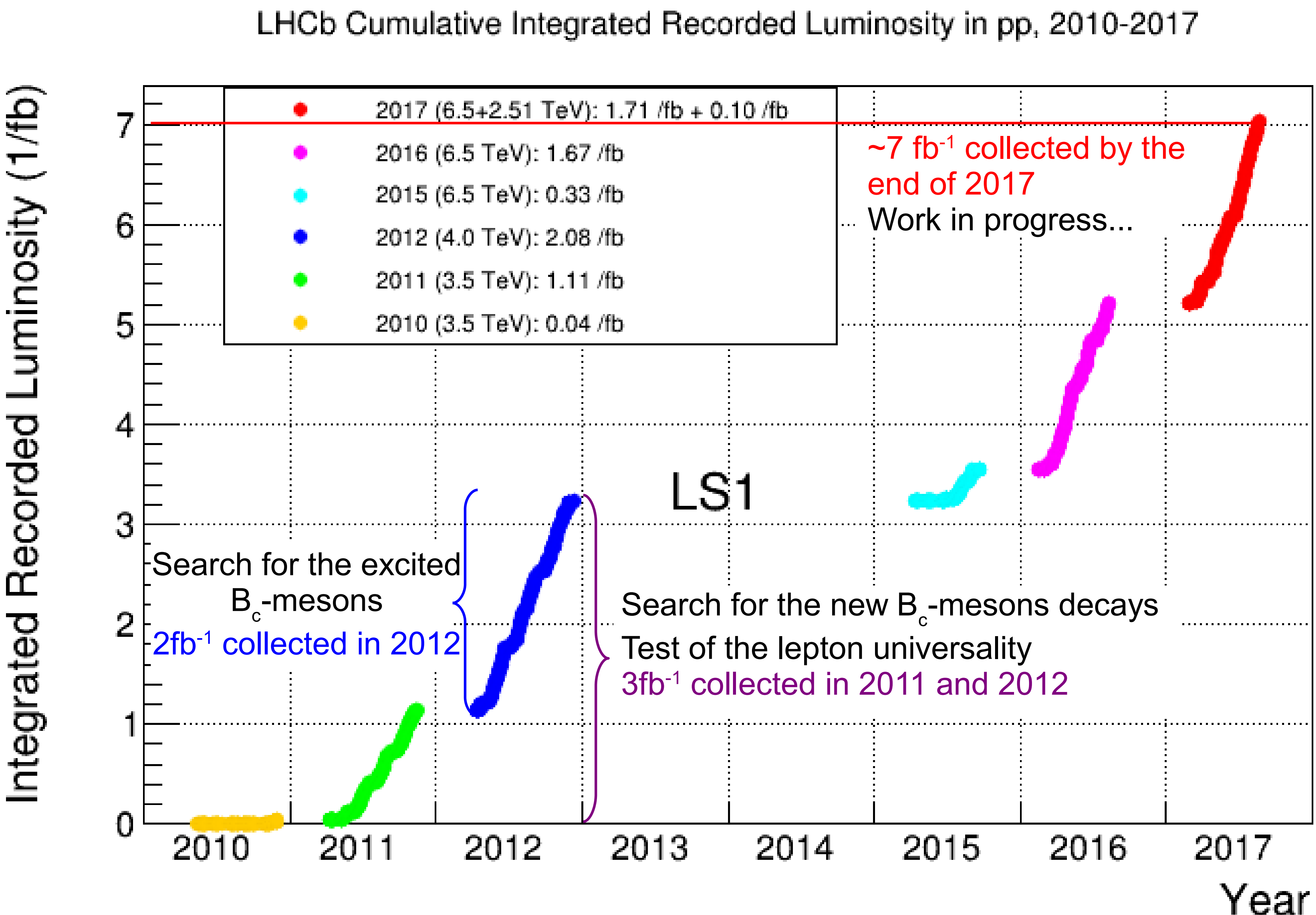
4 different values of reconstructed mass difference between $B_c(2^1S_0)$ and $B_c(2^3S_1)$

Scan over the signal mass range

- $B_c(2^1S_0)$: [6830, 6890] MeV/c^2
- $B_c(2^3S_1)$: [6795, 6890] MeV/c^2



Data



LHCb Cumulative Integrated Recorded Luminosity in pp, 2010-2017
2017 (6.5+2.51 TeV): 1.71 /fb + 0.10 /fb
2016 (6.5 TeV): 1.67 /fb
2015 (6.5 TeV): 0.33 /fb
2012 (4.0 TeV): 2.08 /fb
2011 (3.5 TeV): 1.11 /fb
2010 (3.5 TeV): 0.04 /fb
~7 fb^{-1} collected by the end of 2017
Work in progress...
LS1
Search for the excited B_c-mesons
2fb^{-1} collected in 2012
Search for the new B_c-mesons decays
Test of the lepton universality
3fb^{-1} collected in 2011 and 2012
Integrated Recorded Luminosity (1/fb)
Year
2010
2011
2012
2013
2014
2015
2016
2017