Charmless B decays at LHCb

Only run-I data

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On behalf of the LHCb collaboration

Baryonic B decays – motivation

- Inclusive branching fraction to baryonic final states ~ 7% of B-meson total width !
  - Most decay modes still to be studied / observed

- Threshold enhancement in baryon-antibaryon system observed in many decay modes
  [see e.g. “The physics of the B factories”, Eur. Phys. J. C74 (2014) 3026]

- Many-body final states tend to have a larger BF than 3- and 2-body final states

$$\mathcal{B}(\overline{B}^0 \to \Lambda_c^+ \overline{p}\pi^+\pi^-) \gg \mathcal{B}(\overline{B}^0 \to \Lambda_c^+ \overline{p}\pi^0) \gg \mathcal{B}(\overline{B}^0 \to \Lambda_c^+ \overline{p}),$$

$$\begin{aligned} \mathcal{B}(\overline{B} \to \mathfrak{B}_{1c}\overline{\mathfrak{B}}_{2c}) &\sim 10^{-3} \\ \gg \mathcal{B}(\overline{B} \to \mathfrak{B}_c\overline{\mathfrak{B}}) &\sim 10^{-5} \\ \gg \mathcal{B}(\overline{B} \to \mathfrak{B}_1\overline{\mathfrak{B}}_2) &\lesssim 10^{-6} \end{aligned}$$

- Theoretical description is a challenge and various models “in competition”

Baryonic B decays – short history & highlights

B factories

- 2002: 1st observation of a baryonic B decay, $B^+ \to p\,\bar{p}\,K^+$
- 2013: 1st evidence for a baryonic B_s decay, $B_s^0 \to \bar{\Lambda}_c^-\,\Lambda\,\pi^-$ [Phys. Lett. B 726 (2013)]
- Many B^0 and B^+ baryonic decays observed and studied, with charm in the final state, or charmless
- Experimental observation of threshold enhancement in baryon-antibaryon invariant mass in several decay modes

LHC(b)

- 2013: 1st observation of a 2-body charmless baryonic mode: $B^+ \to p\,\bar{\Lambda}(1520)$ [PRL 113, 141801 (2014)]

  1st evidence for CP violation in a baryonic B decay, seen in $B^+ \to p\,\bar{p}\,K^+$ [PRL 113, 141801 (2014)]

  1st evidence for very suppressed $B^0 \to p\,\bar{p}$ with 2011 data analysis [JHEP 10 (2013) 005]
- 2014: 1st observation of a baryonic B_c^+ decay, $B_c^+ \to J/\psi\,p\,\bar{p}\,\pi^+$ [PRL 113, 152003 (2014)]
- 2016: 1st evidence for suppressed $B^+ \to p\,\bar{\Lambda}$ [JHEP 04 (2017) 162]

  1st observation of a baryonic B_s^0 decay, $B_s^0 \to p\,\bar{\Lambda}\,K^-$ [arXiv:1704.07908 [hep-ex]]

  Observation of charmless $B_{(s)}^0 \to p\,\bar{p}\,h^+h'^-$ decays [arXiv:1704.08497 [hep-ex]]
- 2017: …?

1st observation of the purely baryonic decay $B^0 \to p\,\bar{p}$

LHCb-PAPER-2017-022

$B^0_{(s)} \to p\,\bar{p}$ – motivation

LHCb-PAPER-2017-022

- 2-body baryonic B decays are rather suppressed ⇒ need LHCb, as not seen @ B factories
- 1st evidence for $B^0 \to p\,\bar{p}$ with 2011 data analysis, no B^0_s signal **[JHEP 10 (2013) 005]**

$$\mathcal{B}(B^0 \to p\bar{p}) = \left(1.47\,^{+0.62\,+0.35}_{-0.51\,-0.14}\right) \times 10^{-8} \text{ at } 68.3\% \text{ CL}$$

$$\mathcal{B}(B^0 \to p\bar{p}) = \left(1.47\,^{+1.09\,+0.69}_{-0.81\,-0.18}\right) \times 10^{-8} \text{ at } 90\% \text{ CL}$$

$$\mathcal{B}(B^0_s \to p\bar{p}) = \left(2.84\,^{+2.03\,+0.85}_{-1.68\,-0.18}\right) \times 10^{-8} \text{ at } 68.3\% \text{ CL}$$

$$\mathcal{B}(B^0_s \to p\bar{p}) = \left(2.84\,^{+3.57\,+2.00}_{-2.12\,-0.21}\right) \times 10^{-8} \text{ at } 90\% \text{ CL}$$

(Full overview of experimental data on 2-body decays at end of presentation.)

- 1st observation of a 2-body charmless baryonic mode: $B^+ \to p\,\bar{\Lambda}(1520)$ **[PRL 113, 141801 (2014)]**

⇒ Important to confirm and/or improve knowledge of these very rare decays $B^0_{(s)} \to p\,\bar{p}$

- Most recent calculations explain a BF ~ 10^{-8} for the B0 mode

  [Phys. Rev. D91 (2015) 077501; Phys. Rev. D91 (2015) 036003]

$B^0_{(s)} \to p\,\bar{p}$ – analysis strategy

LHCb-PAPER-2017-022

Analysis strategy & data

- Analysis on full data sample from the 1st run of the LHC
- Blinded search – both B^0 and B^0_s signal regions blinded (± 50 MeV around both masses)
- Branching fraction measured relative to normalisation mode $B^0 \to K^+\,\pi^+$
  - Topologically identical decay, large BF

$$\mathcal{B}(B^0_{(s)} \to p\bar{p}) = \frac{N(B^0_{(s)} \to p\bar{p})}{N(B^0 \to K^+\pi^-)} \frac{\varepsilon_{B^0 \to K^+\pi^-}}{\varepsilon_{B^0_{(s)} \to p\bar{p}}} \mathcal{B}(B^0 \to K^+\pi^-) \left(\times \frac{f_d}{f_s}\right)$$

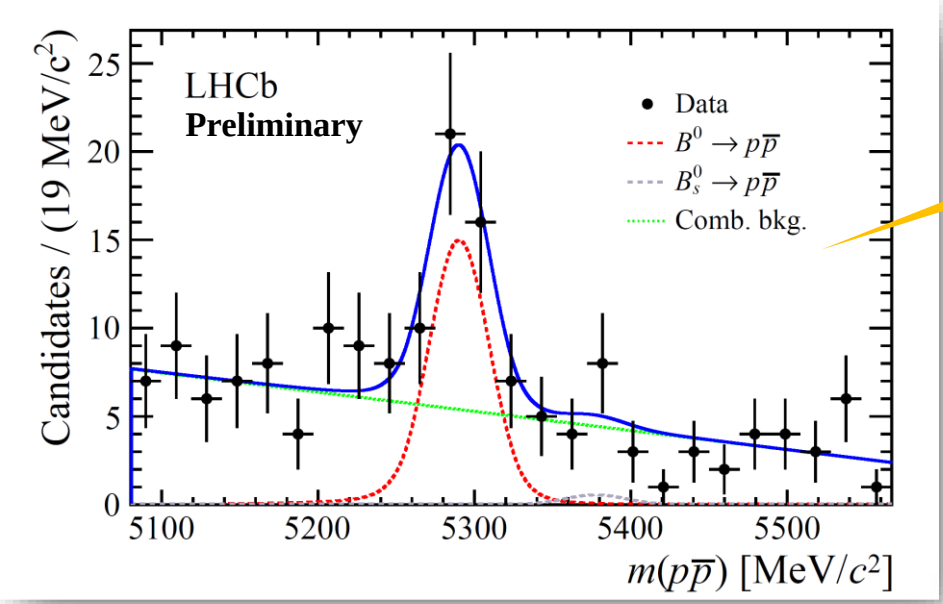
- Similar selection for both decay modes

Background studies

- Very important given the rareness of the decay modes investigated
- Various "families" of backgrounds considered
  - $H_b \to h\ h'$ & $B \to h\ h'\ h''$
  - Baryonic B decays & many-body Λ_b decays
  - Semi-leptonic decays with $B^+ \to p\,\bar{p}\,l^+\,\nu$

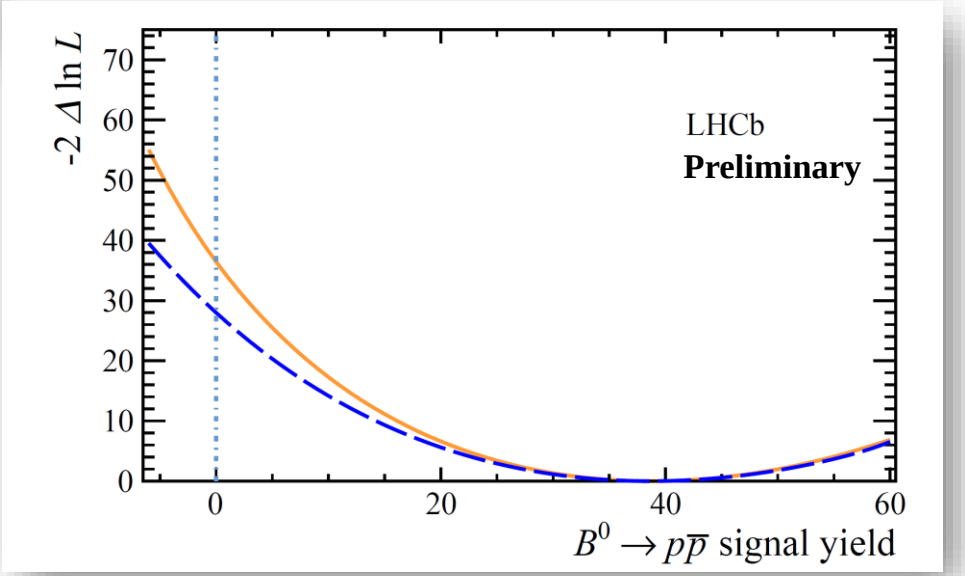
First observation of $B^0 \to p\,\bar{p}$!

LHCb-PAPER-2017-022



Clear peak !

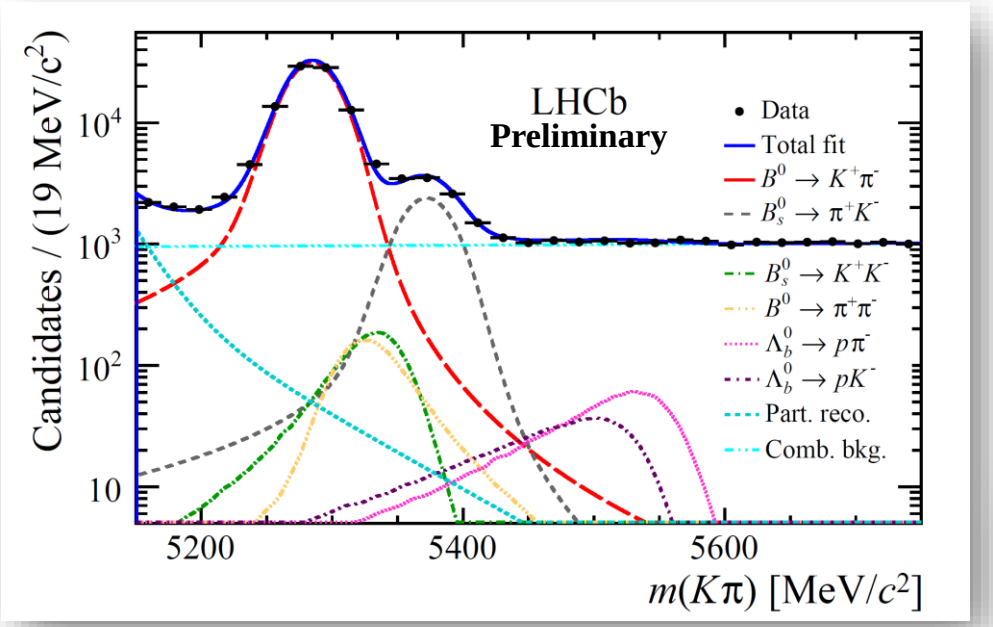
$$N(B^0 \to p\bar{p}) = 39 \pm 8$$
$$N(B_s^0 \to p\bar{p}) = 2 \pm 4$$



- **Statistical significance = 6.0σ**
  - **5.3σ with systematic uncertainties included**
- **First observation of a charmless 2-body baryonic B^0 decay !**

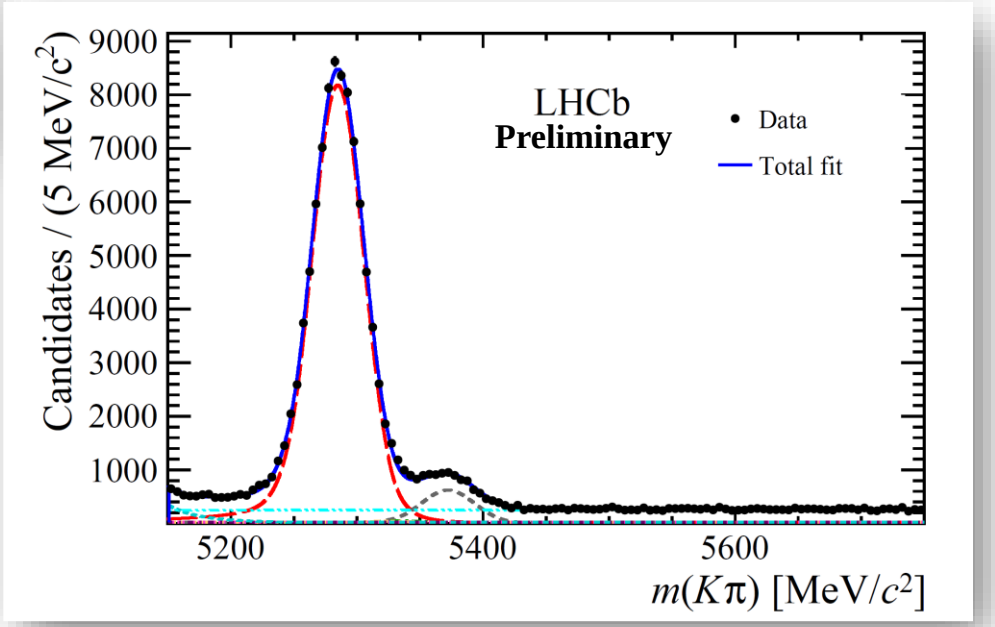
$B^0_{(s)} \to p\,\bar{p}$ – fits to the normalisation decay

LHCb-PAPER-2017-022



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

Very clean spectrum !



$$N(B^0 \to K^+\pi^-) = 88\,961 \pm 341$$

$B^0_{(s)} \to p\,\bar{p}$ – analysis results

LHCb-PAPER-2017-022

- Run-I search for the rare 2-body charmless $B^0_{(s)} \to p\,\bar{p}$ decays
- First observation of the B^0 mode with a signal significance of 5.3σ
- Branching fraction measurements:

$$\mathcal{B}(B^0 \to p\bar{p}) = (1.25 \pm 0.27 \pm 0.18) \times 10^{-8}$$

$$\mathcal{B}(B^0_s \to p\bar{p}) < 1.5 \times 10^{-8} \text{ at } 90\% \text{ confidence level}$$

  - UL calculated with the Feldman-Cousins method

- Rarest B^0 decay ever observed, and also rarest hadronic B decay ever observed !

✓ **Paper to be submitted to Phys. Rev. Lett.**

First observation of a baryonic B_s decay

arXiv:1704.07908 [hep-ex]; accepted for publication in PRL

Search for $B_s^0 \to p\,\overline{\Lambda}\,K^-$ – analysis

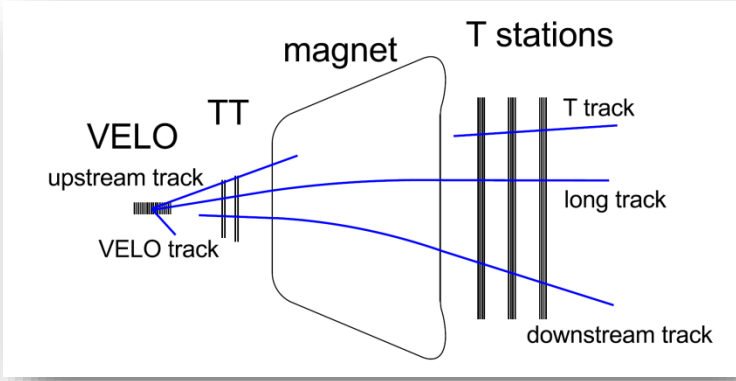
arXiv:1704.07908 [hep-ex]

Analysis strategy

- Branching fraction measured relative to normalisation mode $B^0 \to p\,\overline{\Lambda}\,\pi^-$
  - Topologically identical decay, large branching fraction

$$\mathcal{B}(B_s^0 \to p\overline{\Lambda}K^-) + \mathcal{B}(B_s^0 \to \overline{p}\Lambda K^+) = \frac{f_d}{f_s}\,\frac{N(B_s^0 \to p\overline{\Lambda}K^-)}{N(B^0 \to p\overline{\Lambda}\pi^-)}\,\frac{\epsilon_{B^0 \to p\overline{\Lambda}\pi^-}}{\epsilon_{B_s^0 \to p\overline{\Lambda}K^-}}\,\mathcal{B}(B^0 \to p\overline{\Lambda}\pi^-)$$

- Similar selection for both decay modes



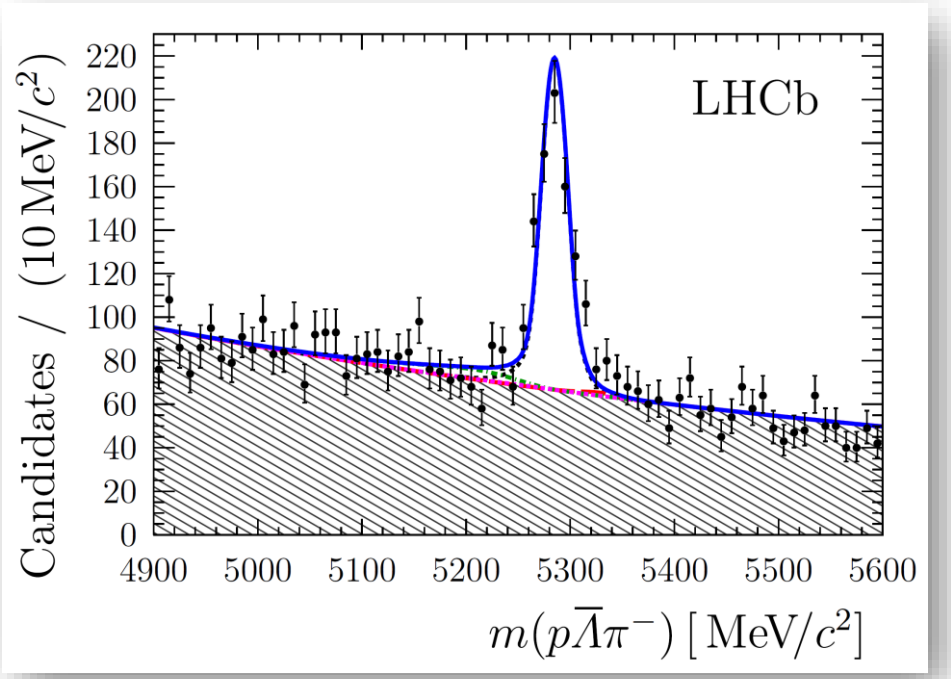
Data

- Analysis on full run-I data sample
- Data split according to year and V^0 reconstruction category (***long*** or ***downstream*** tracks)
  - Studies proved a viable procedure to merge all subsamples for the mass fit
- Decay chain fitted with V^0 mass constrained

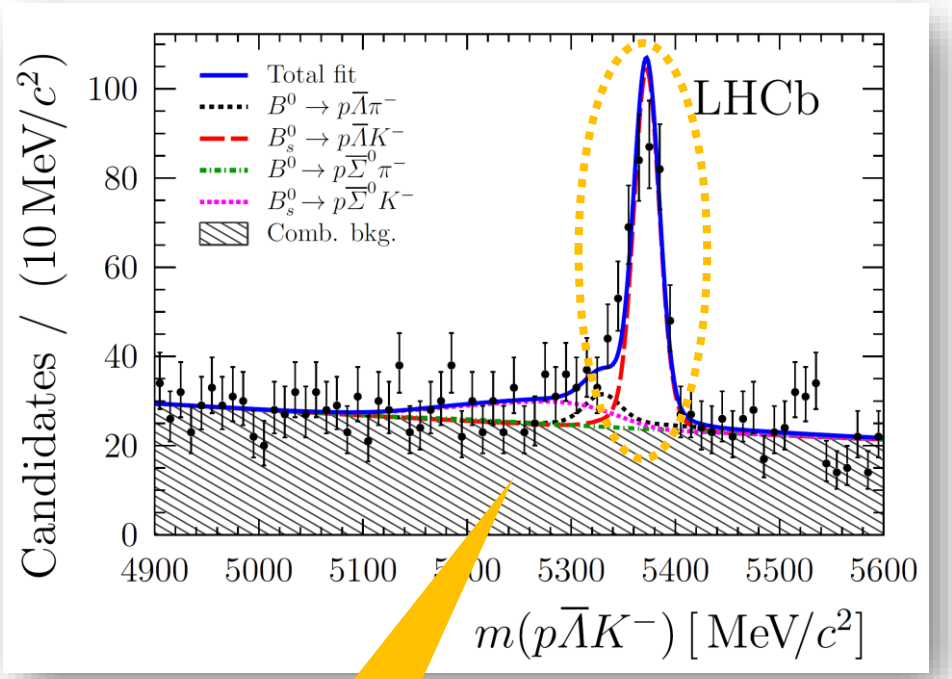
1st obs of a baryonic B_s decay – fit projections

arXiv:1704.07908 [hep-ex]

$B^0 \to p\bar{\Lambda}\pi$



$B_s \to p\bar{\Lambda}K$



❑ Downstream & long samples combined

1st observation !

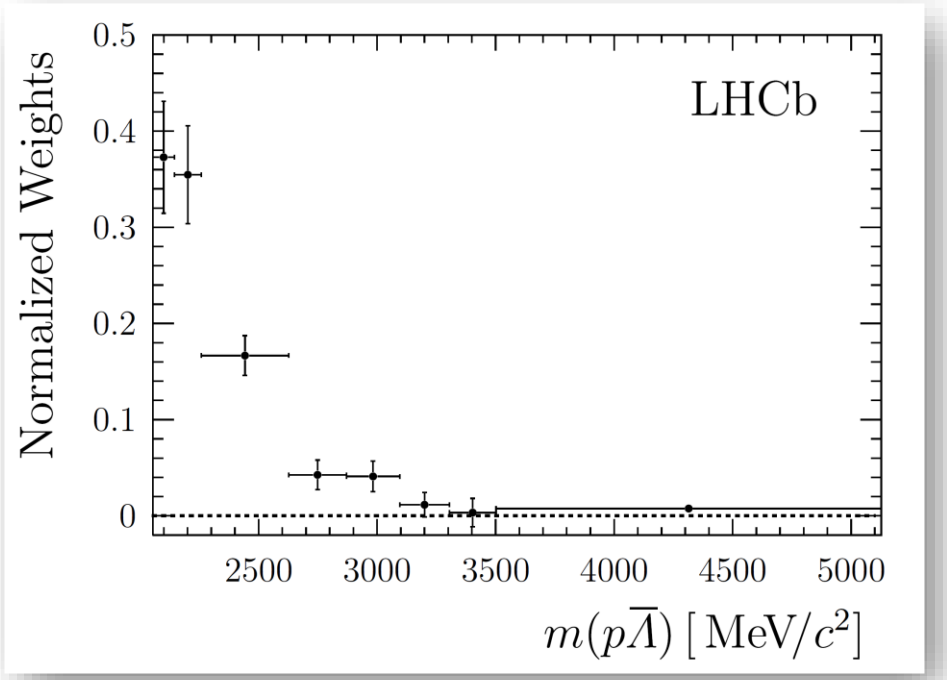
1st obs of a baryonic B_s decay – 2-part. proj.

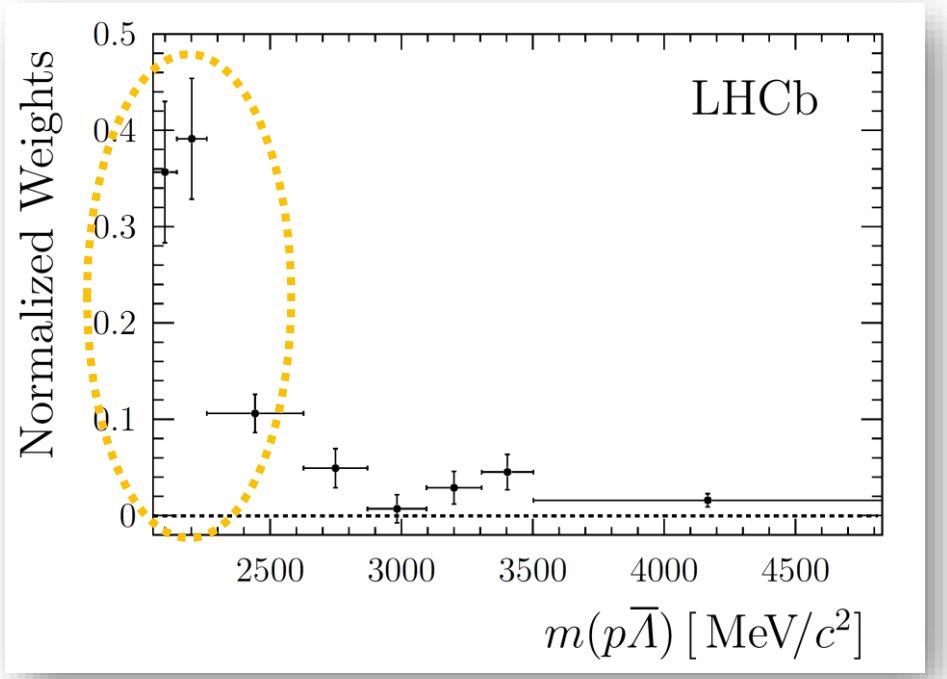
arXiv:1704.07908 [hep-ex]

1st observation of threshold enhancement in baryonic B_s decays

$B^0 \to p\bar{\Lambda}\pi$

$B_s \to p\bar{\Lambda}K$





First observation of a baryonic B_s decay

arXiv:1704.07908 [hep-ex]

- First observation of a baryonic B_s decay !
- With a statistical significance of > 15σ

- Branching fraction measured to be

(Note: BF calculated assuming that effective lifetime is the average B_s lifetime)

$$\mathcal{B}(B_s^0 \to p\overline{\Lambda}K^-) + \mathcal{B}(B_s^0 \to \overline{p}\Lambda K^+) = \left[5.46 \pm 0.61 \pm 0.57 \pm 0.50(\mathcal{B}) \pm 0.32(f_s/f_d)\right] \times 10^{-6}$$

Uncertainty on $B^0 \to p\overline{\Lambda}\pi$ branching fraction

Uncertainty on ratio of fragmentation probabilities

Result opens a new area of research on baryonic B decays

- So far baryonic B_s decays had only been theo. studied [PRD 91 (2015) 077501; PRD 89 (2014) 056003] in the case of 2-body final states following the 1st evidence for $B^0 \to p\,\overline{p}$ reported by LHCb in 2013 [JHEP 10 (2013) 005] and in charmed baryonic decays [EPJ C 75 (2015) 101]

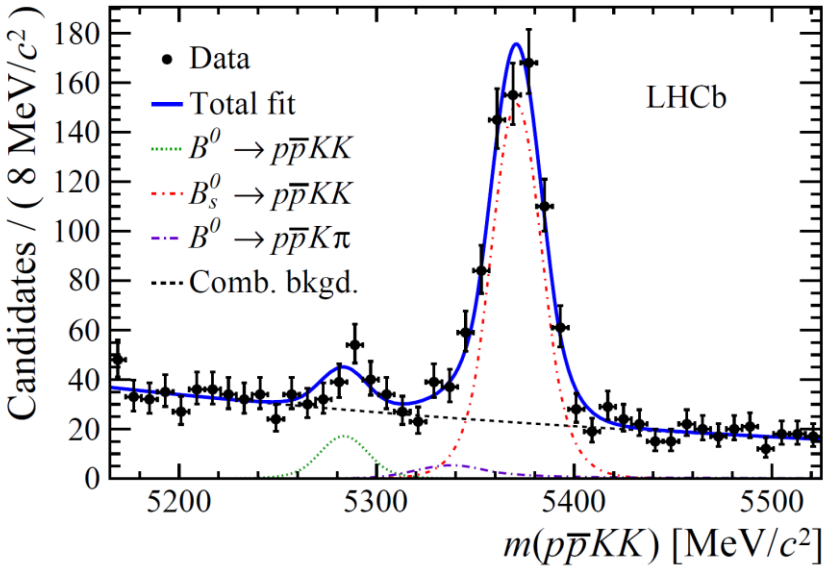
- Decay-time-dependent CP violation measurements interesting with this unique baryonic decay [PLB 767 (2016) 205]

Observation of charmless $B^0_{(s)} \to p\,\bar{p}\,h^+\,h'^-$ decays

arXiv:1611.08497 [hep-ex]

$B^0_{(s)} \to p\,\bar{p}\,h^+\,h'^-$ – simultaneous fit results

arXiv:1704.08497 [hep-ex]



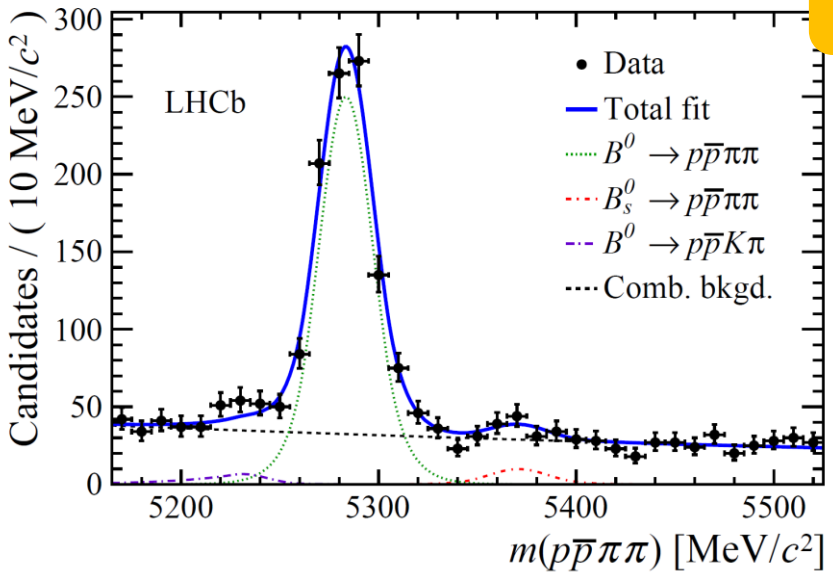
$n_B^{p\bar{p}K^+K^-} = 68 \pm 17$ $\quad n_{B_s}^{p\bar{p}K^+K^-} = 635 \pm 32$

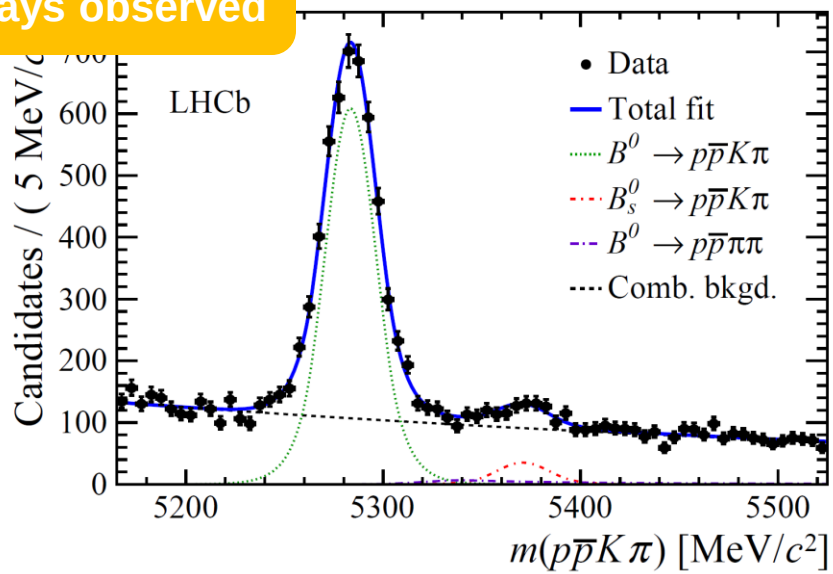
$n_B^{p\bar{p}K^\pm\pi^\mp} = 4155 \pm 83$ $\quad n_{B_s}^{p\bar{p}K^\pm\pi^\mp} = 246 \pm 39$

$n_B^{p\bar{p}\pi^+\pi^-} = 902 \pm 35$ $\quad n_{B_s}^{p\bar{p}\pi^+\pi^-} = 39 \pm 16$

First strong evidence First observations

Yet more baryonic B_s decays observed

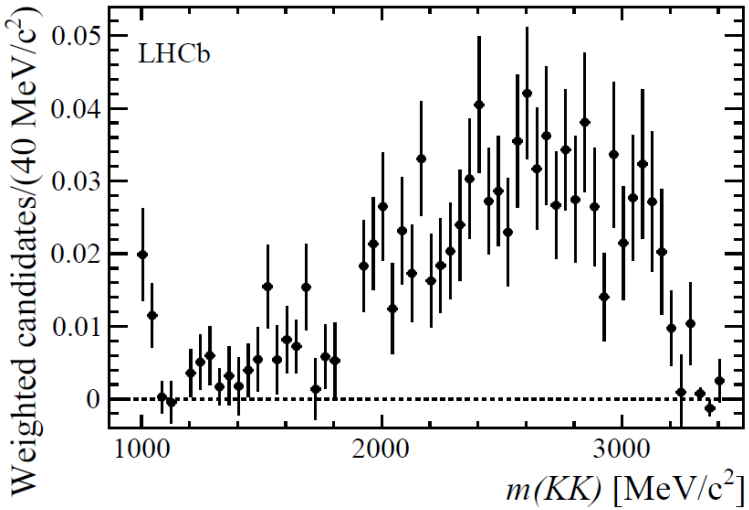




$B^0_{(s)} \to p\,\bar{p}\,h^+\,h'^-$ – 2-particle projections

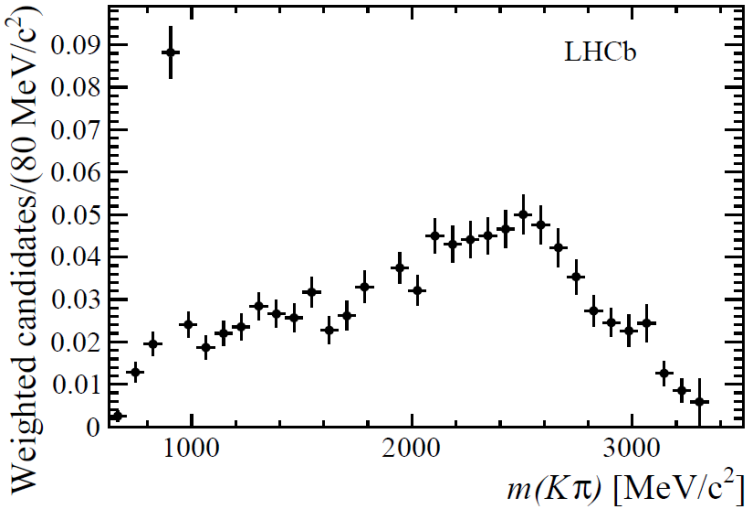
arXiv:1704.08497 [hep-ex]

$B^0_s \to p\bar{p}K^+K^-$

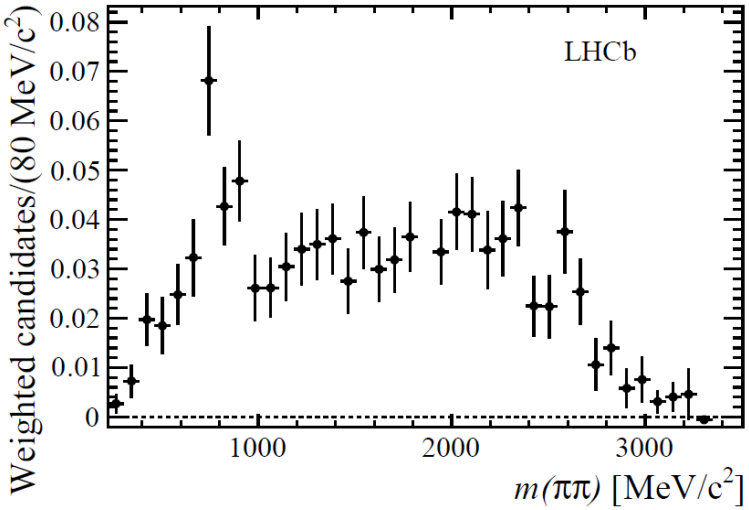


- Efficiency-corrected and background-subtracted
- Vector mesons visible ($\phi(1020)$, $K^*(892)^0$, $\rho^0(770)$)

$B^0 \to p\bar{p}K^\pm\pi^\mp$



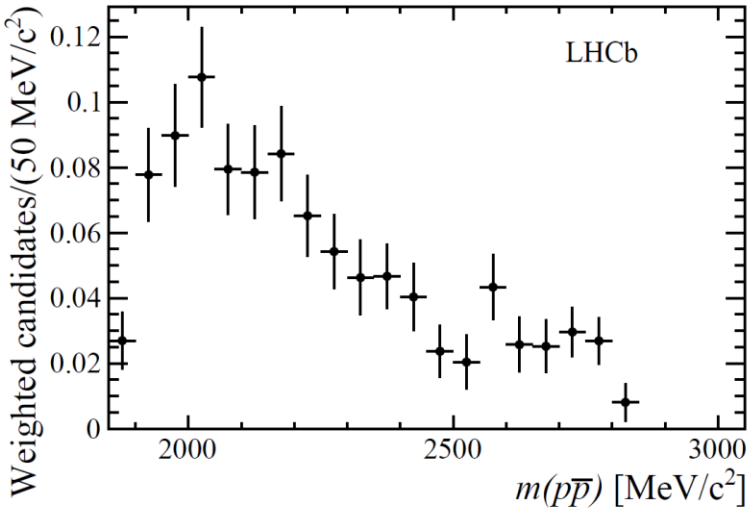
$B^0 \to p\bar{p}\pi^+\pi^-$



$B^0_{(s)} \to p\,\bar{p}\,h^+\,h'^-$ – threshold enhancement

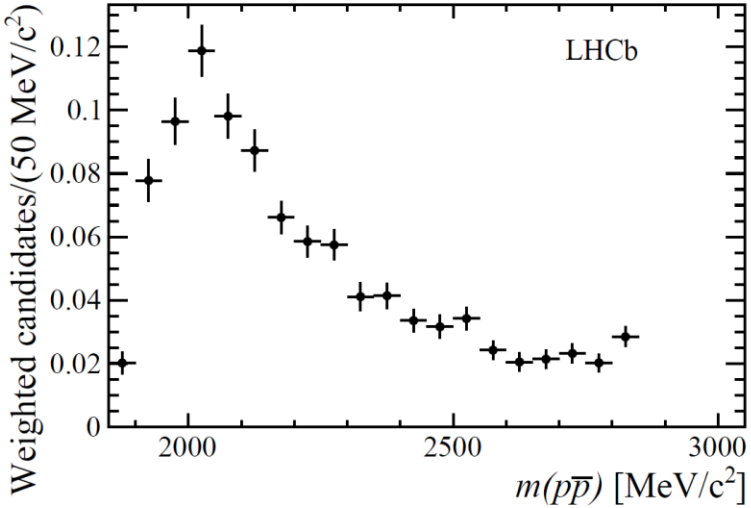
arXiv:1704.08497 [hep-ex]

$B^0_s \to p\bar{p}K^+K^-$

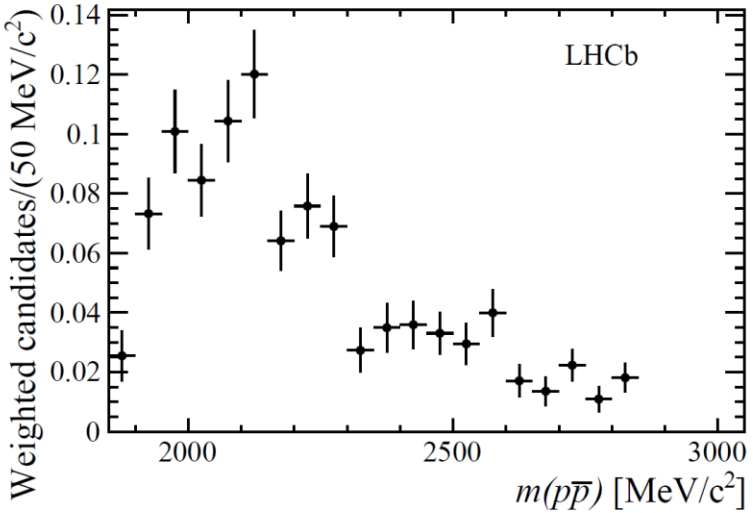


- Efficiency-corrected and background-subtracted
- Clear threshold enhancement

$B^0 \to p\bar{p}K^\pm\pi^\mp$



$B^0 \to p\bar{p}\pi^+\pi^-$



$B^0_{(s)} \to p\,\bar{p}\,h^+\,h'^-$ decays – branching fractions

arXiv:1704.08497 [hep-ex]

- 3 first observations and a strong evidence

Decay channel	Significance [σ]	Branching fraction / 10^{-6}			
$B^0 \to p\bar{p}K^+K^-$	4.1	$0.126 \pm 0.031 \pm 0.013 \pm 0.006$			
$B^0 \to p\bar{p}K^\pm\pi^\mp$	> 25	6.6	± 0.3	± 0.3	± 0.3
$B^0 \to p\bar{p}\pi^+\pi^-$	> 25	3.0	± 0.2	± 0.2	± 0.1
$B^0_s \to p\bar{p}K^+K^-$	> 25	4.6	± 0.3	± 0.3	± 0.2 ± 0.3
$B^0_s \to p\bar{p}K^\pm\pi^\mp$	6.5	1.45	± 0.24	± 0.12	± 0.07 ± 0.08
$B^0_s \to p\bar{p}\pi^+\pi^-$	2.6	0.46	± 0.19	± 0.05	± 0.02 ± 0.03

$$val \pm stat \pm syst \pm \sigma(\mathcal{B}) \pm \sigma(f_s/f_d)$$

- Upper limit set on $\mathcal{B}(B^0_s \to p\bar{p}\pi^+\pi^-)$

$$\mathcal{B}(B^0_s \to p\bar{p}\pi^+\pi^-) < 7.3 \times 10^{-7} \text{ at } 90\% \text{ CL}$$

Updated BF measurements of $B^0_{(s)} \to K^0_S h^+ h'^-$ decays

LHCb-PAPER-2017-010; to appear in the arXiv tomorrow

Update on $B^0_{(s)} \to K^0_S\, h^+\, h'^-$ branching fractions

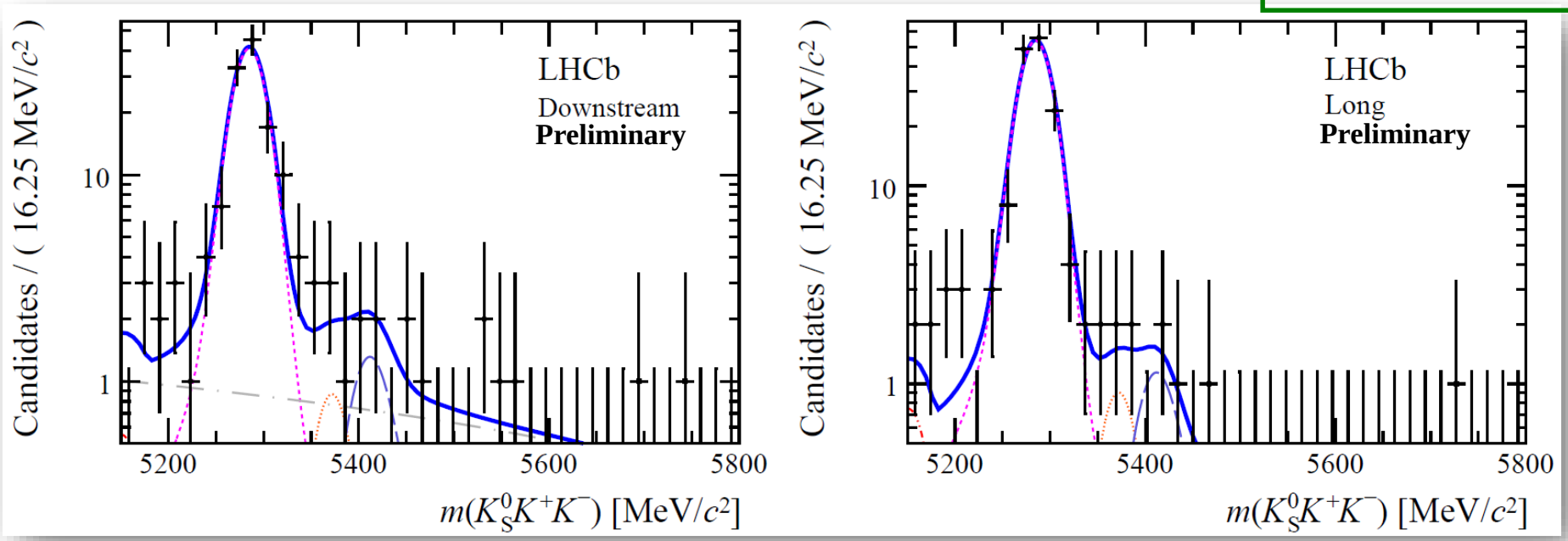
LHCb-PAPER-2017-010

- Update of LHCb analysis on 2011 data with goal of
  - Update all BF measurements for all modes
  - Hopefully observe the missing mode, i.e., $B^0_s \to K^0_S\, K^+\, K^-$
  - As a by-product, define a new optimised selection for the Dalitz plot analyses of the favoured modes

- Family of modes with great physics potential:
  - From Dalitz-plot analyses
  - Contribution to extractions of angle γ, weak phase of B^0 mixing

- Fit with selection optimization chosen for the suppressed decay mode :

Still no observation of only missing member of the family !
- Significance is 2.5σ



Update on $B^0_{(s)} \to K^0_S\, h^+\, h'^-$ branching fractions

LHCb-PAPER-2017-010

$$\frac{\mathcal{B}(B^0 \to K^0_S K^\pm \pi^\mp)}{\mathcal{B}(B^0 \to K^0_S \pi^+\pi^-)} = 0.123 \pm 0.009\ (\text{stat.}) \pm 0.015\ (\text{syst.}),$$

$$\frac{\mathcal{B}(B^0 \to K^0_S K^+ K^-)}{\mathcal{B}(B^0 \to K^0_S \pi^+\pi^-)} = 0.549 \pm 0.018\ (\text{stat.}) \pm 0.033\ (\text{syst.}),$$

$$\frac{\mathcal{B}(B^0_s \to K^0_S \pi^+\pi^-)}{\mathcal{B}(B^0 \to K^0_S \pi^+\pi^-)} = 0.191 \pm 0.027\ (\text{stat.}) \pm 0.031\ (\text{syst.}) \pm 0.011\ (f_s/f_d),$$

$$\frac{\mathcal{B}(B^0_s \to K^0_S K^\pm \pi^\mp)}{\mathcal{B}(B^0 \to K^0_S \pi^+\pi^-)} = 1.70 \pm 0.07\ (\text{stat.}) \pm 0.11\ (\text{syst.}) \pm 0.10\ (f_s/f_d),$$

$$\frac{\mathcal{B}(B^0_s \to K^0_S K^+ K^-)}{\mathcal{B}(B^0 \to K^0_S \pi^+\pi^-)} \in [0.008 - 0.051]\ \text{at } 90\%\ \text{confidence level.}$$

From uncertainty on ratio of hadronisation fractions of the B^0 and B_s mesons

⇒ **Using the world-average value of the normalisation mode (omitting the previous LHCb result) :**

$$\mathcal{B}(B^0 \to \overline{K}^{(*)0} K^\pm \pi^\mp) = (6.1 \pm 0.5 \pm 0.7 \pm 0.3) \times 10^{-6}$$
$$\mathcal{B}(B^0 \to K^0 K^+ K^-) = (27.2 \pm 0.9 \pm 1.6 \pm 1.1) \times 10^{-6}$$
$$\mathcal{B}(B^0_s \to K^0 \pi^+\pi^-) = (9.5 \pm 1.3 \pm 1.5 \pm 0.4) \times 10^{-6}$$
$$\mathcal{B}(B^0_s \to \overline{K}^{(*)0} K^\pm \pi^\mp) = (84.3 \pm 3.5 \pm 7.4 \pm 3.4) \times 10^{-6}$$
$$\mathcal{B}(B^0_s \to K^0 K^+ K^-) \in [0.4 - 2.5] \times 10^{-6}\ \text{at } 90\%\ \text{C.L.}$$

❑ **Dalitz plot analysis of the 3 dominant modes is under way … !**

1st uncertainty: statistical
2nd uncertainty: systematic
3rd uncertainty: $\mathcal{B}(B^0 \to K^0 \pi^+\pi^-)$

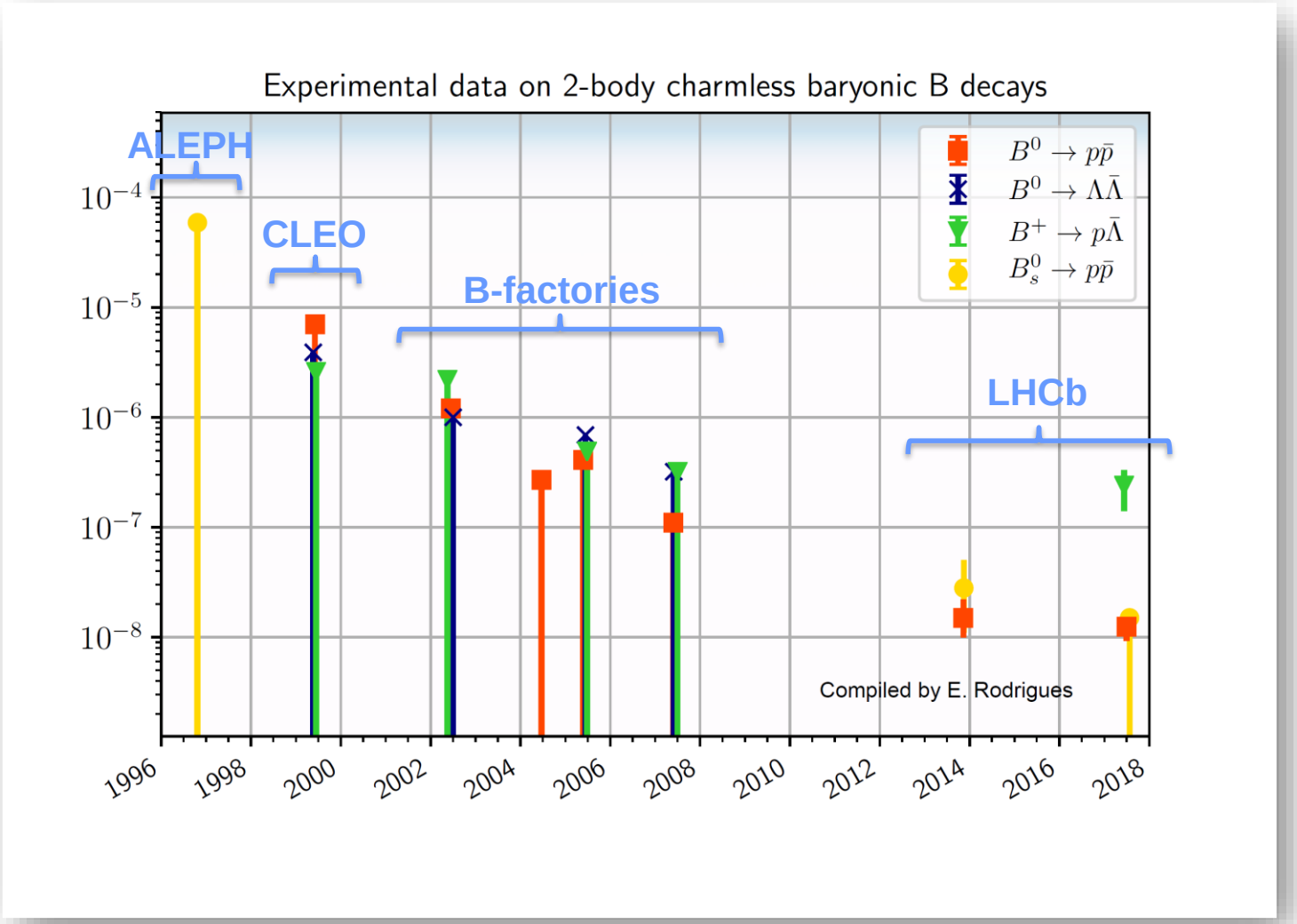
In short

- LHCb is very active in the study of charmless B decays
- In particular, it has recently provided a plethora of important results with baryonic final states
  - Baryonic B decays still surprising us after almost 2 decades since first interest by community

- Many other results on charmless B decays not presented here:
  - 1st observation of $\Xi_b^- \to p\, K^-\, K^-$ **[PRL 118, 071801 (2017)]**
- This decay, and others, is very interesting as far as CP violation studies are concerned
  - See Sevda Esen's talk on July 7th @ 16h30 on "Time-dependent CP violation in the B system at LHCb ", Rafael Coutinho's talk on July 7th @ 16h45 on "CP violation in b baryons at LHCb"

- Run II will provide a lot more statistics
- The LHCb detector and data collection flow is much improved also !
- *Expect a lot and hope for surprises !*

To wrap-up – where do we stand for 2-body decays ?



Upper limits

1st evidences or observations

Thank you

Back-up slides

$B^0_{(s)} \to p\,\bar{p}$ – systematic uncertainties

- **Systematic uncertainties on the branching fractions**
  - **Dominated by uncertainties on the fit model and on the selection efficiencies**

Uncertainty origin	Value (%)	
	$B^0 \to p\bar{p}$	$B^0_s \to p\bar{p}$
Trigger	3.1	3.1
Tracking	6.1	6.1
Selection	8.6	8.3
Particle identification	4.7	4.6
Mass fits	7.3	208
$B^0 \to K^+\pi^-$ branching fraction	2.6	2.6
f_s/f_d	–	5.8
Total systematic uncertainty	14.2	209
Statistical uncertainty	21.6	34.1

$B^0_{(s)} \to p\,\bar{p}$ – old analysis results on 2011 data

JHEP 10 (2013) 005

- First evidence for a 2-body charmless baryonic B^0 decay ! (significance: 3.3σ)

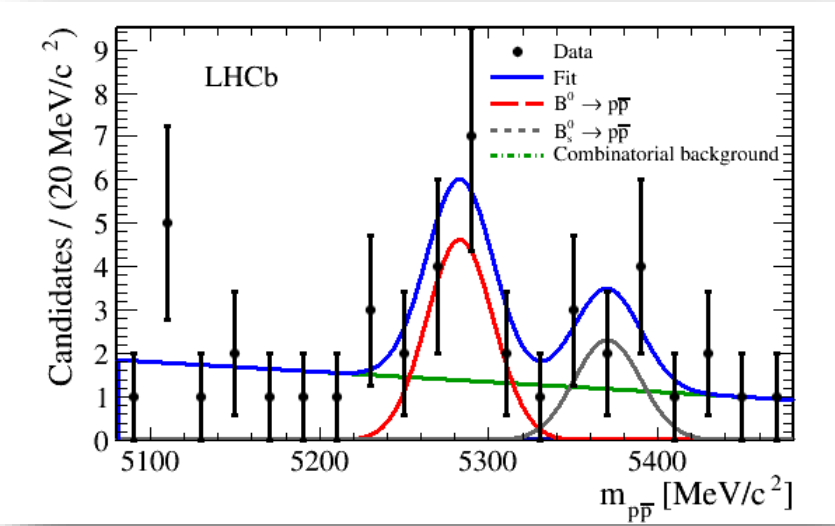
- No significant B_s signal observed and published result improved previous search by 3 orders of magnitude

$$\mathcal{B}(B^0 \to p\bar{p}) = \left(1.47\,^{+0.62\ +0.35}_{-0.51\ -0.14}\right) \times 10^{-8} \text{ at } 68.3\%\ \text{CL}$$

$$\mathcal{B}(B^0 \to p\bar{p}) = \left(1.47\,^{+1.09\ +0.69}_{-0.81\ -0.18}\right) \times 10^{-8} \text{ at } 90\%\ \text{CL}$$

$$\mathcal{B}(B^0_s \to p\bar{p}) = \left(2.84\,^{+2.03\ +0.85}_{-1.68\ -0.18}\right) \times 10^{-8} \text{ at } 68.3\%\ \text{CL}$$

$$\mathcal{B}(B^0_s \to p\bar{p}) = \left(2.84\,^{+3.57\ +2.00}_{-2.12\ -0.21}\right) \times 10^{-8} \text{ at } 90\%\ \text{CL}$$



- This $B^0 \to p\,\bar{p}$ branching fraction excluded all theoretical predictions by 1-2 orders of magnitude at the time
  - Motivated newer calculations

Search for baryonic B_s decays – motivation

- Baryonic decays of B mesons had been observed for all B species *except* the B_s meson !
  - Only evidence of $B_s^0 \to \overline{\Lambda}_c^- \Lambda \pi^-$ by Belle

- 2-body modes are rather suppressed ⇒ exploit 3-body final states

- $B_s^0 \to p \overline{\Lambda} K^-$ is a good candidate given that the related mode $B^0 \to p \overline{\Lambda} \pi^-$ has a large branching fraction ~ 3 x 10^{-6} and is well studied

- Experimental situation for $B_{(s)}^0 \to p \overline{\Lambda} h^-$ decays and cousins :

Decay Channel	BaBar $\mathcal{B}$ or UL	Belle $\mathcal{B}$ or UL
$B^0 \to p\overline{\Lambda}\pi^-$	$(3.07 \pm 0.39) \times 10^{-6}$ [18]	$(3.23\,^{+0.33}_{-0.29} \pm 0.29) \times 10^{-6}$ [19]
$B^0 \to p\overline{\Lambda}K^-$	-	$< 8.2 \times 10^{-7}$ [16]
$B_s^0 \to p\overline{\Lambda}K^-$	-	-
$B_s^0 \to p\overline{\Lambda}\pi^-$	-	-
$B^0 \to p\overline{\Sigma}^0\pi^-$	-	$< 3.8 \times 10^{-6}$ [16]
$B_s^0 \to p\overline{\Sigma}^0 K^-$	-	-

- No theoretical predictions were available before the LHCb experimental results became public

1st obs. of a baryonic B_s decay – background studies

Background studies

- Non resonant decays mode $B \to p\,\bar{p}\,\pi h$ $\Rightarrow$ suppressed by Λ selection
- Resonant decays:
  - Charmonia decaying to $p\,\bar{p}$ $\Rightarrow$ suppressed by Λ selection
  - Final states with a K_S instead of a Λ baryon $\Rightarrow$ no contribution from such decays found in data
- Cross-feed from misidentification:
  - Pion-kaon misID between signal and control modes $\Rightarrow$ crucial in fits since part of signal model
  - Proton-pion/kaon misID from $\Lambda_b \to \Lambda\,p\,\bar{p}$ $\Rightarrow$ suppressed thanks to small branching fraction & small tails into signal region
- Partially reconstructed backgrounds:
  - $B_{(s)} \to p\,\bar{\Sigma}^0\,h^-$ $\Rightarrow$ can sneak under signal peaks given small Σ-L mass difference ~ 77 MeV
  - $B^0 \to p\,\bar{\Lambda}\,\rho^-$, $B_s \to p\,\bar{\Lambda}\,K^*$ $\Rightarrow$ largely suppressed by selection

Fit strategy

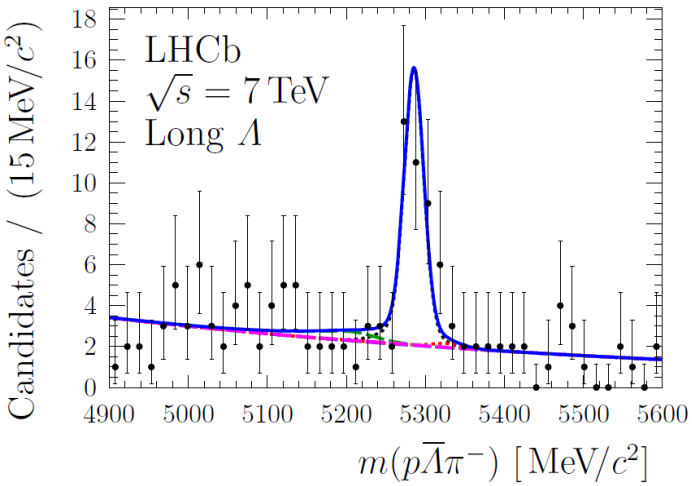
- Simultaneous fit to the 8 spectra : 2 final states x 2 years x 2 Λ reconstruction categories

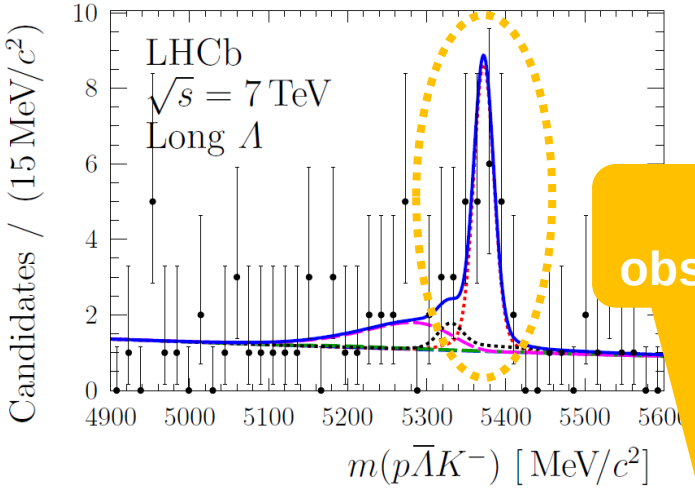
1st obs. of a baryonic B_s decay – 2011 fit proj.

arXiv:1704.07908 [hep-ex]

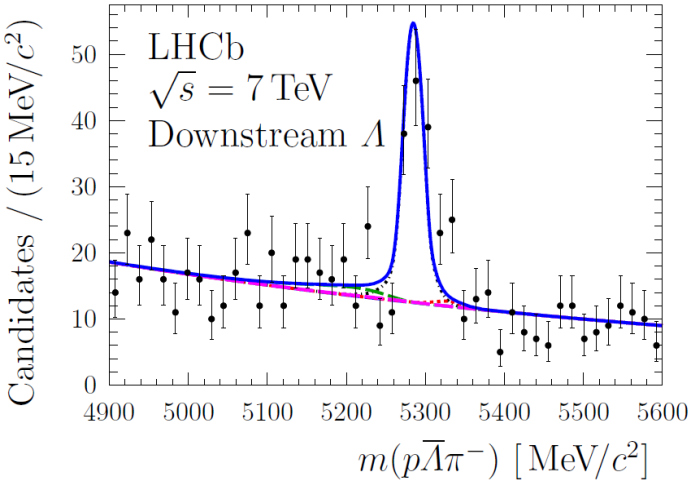
Long sample

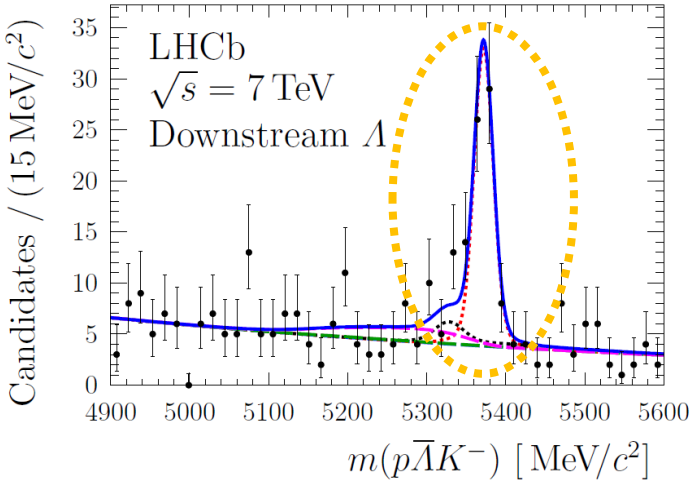
Downstream sample





1st observation !



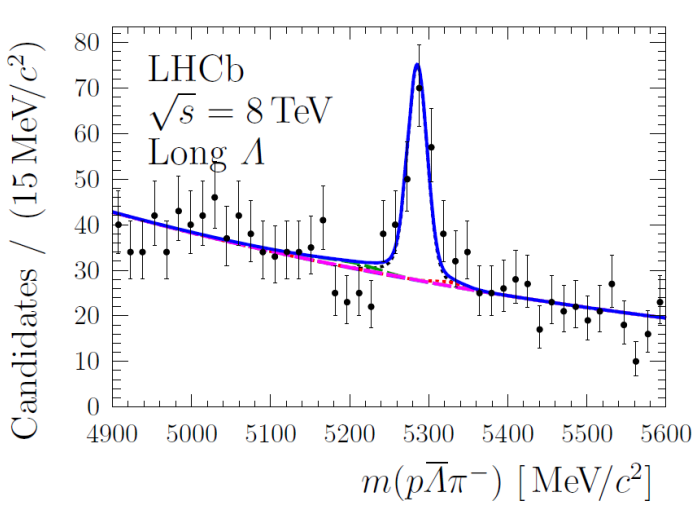


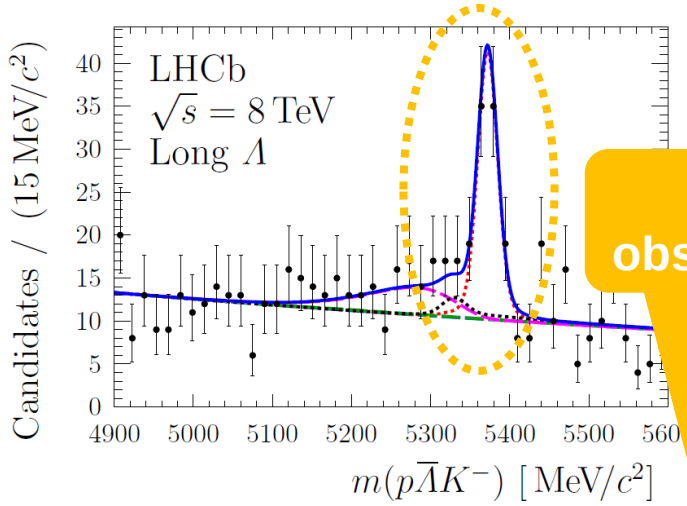
1st obs. of a baryonic B_s decay – 2012 fit proj.

arXiv:1704.07908 [hep-ex]

$p\,\bar{\Lambda}\,\pi$ | $p\,\bar{\Lambda}\,K$

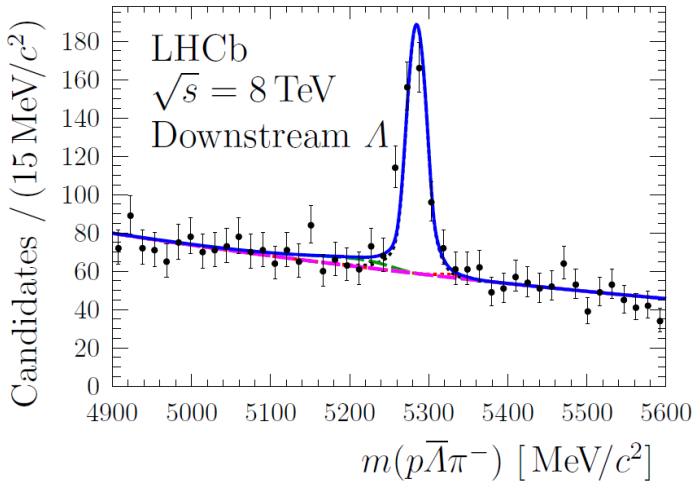
Long sample

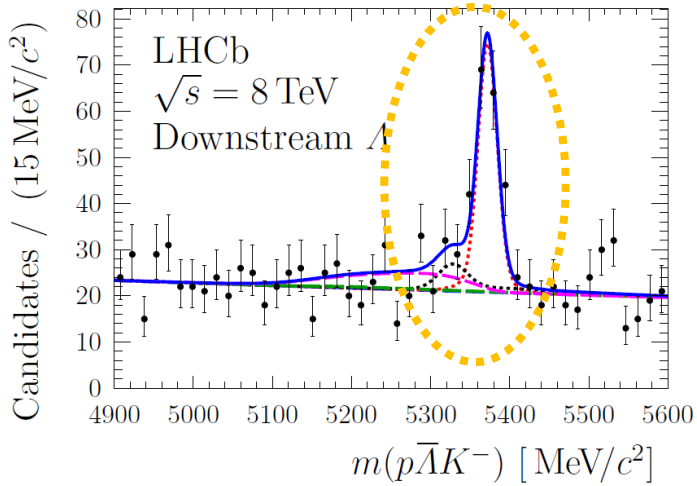




1st observation !

Downstream sample

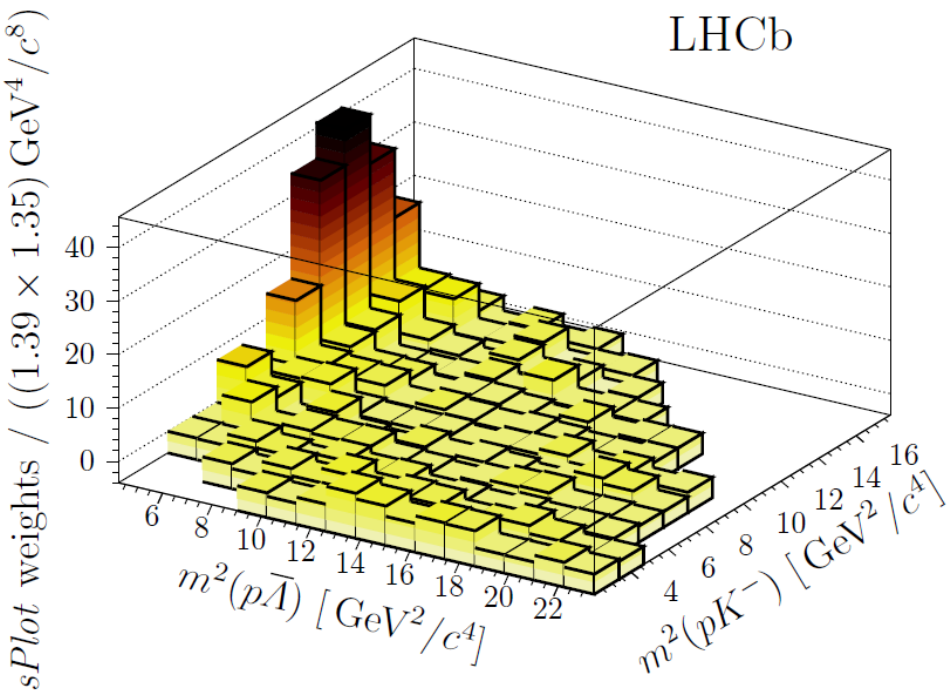




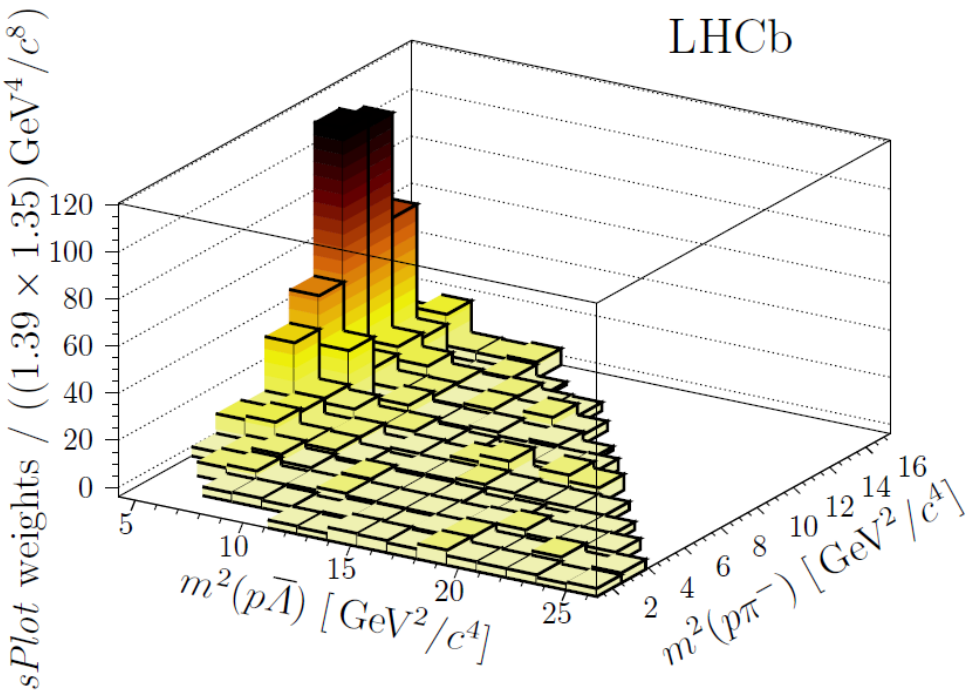
1st obs. of a baryonic B_s decay – 2-part. proj.

arXiv:1704.07908 [hep-ex]

$B^0 \to p\bar{\Lambda}\pi$



$B_s \to p\bar{\Lambda}K$



1st obs. of a baryonic B_s decay – systematics

arXiv:1704.07908 [hep-ex]

- **Systematic uncertainties on the branching fractions**
  - **Fit model uncertainties are large**

Source of uncertainty	Value [%]
Detector acceptance	0.9
Trigger efficiencies	2.2
Tracking efficiencies	0.5
PID uncertainties	1.3
Fit model	9.5
Unknown B_s^0 eigenstate composition	3.3
Total of above	10.5
$\mathcal{B}\,(B^0 \to p\overline{\Lambda}\pi^-)$	9.2
f_s/f_d	5.8

$B^0_{(s)} \to p\,\bar{p}\,h^+\,h'^-$ – systematic uncertainties

arXiv:1704.08497 [hep-ex]

- **Systematic uncertainties on the branching fractions**
  - **Fit model uncertainties are large**

	$B^0 \to p\bar{p}KK$	$B^0 \to p\bar{p}K\pi$	$B^0 \to p\bar{p}\pi\pi$	$B^0_s \to p\bar{p}KK$	$B^0_s \to p\bar{p}K\pi$	$B^0_s \to p\bar{p}\pi\pi$
MC statistics	3.0	1.7	2.1	1.9	4.7	4.1
Efficiency of hardware trigger	3.7	3.7	3.7	3.7	3.7	3.7
Tracking efficiency	1.1	1.1	1.1	1.1	1.1	1.1
Calibration of particle identification	1.9	1.7	1.4	2.0	1.7	1.4
Effect of B_s lifetime	-	-	-	2.6	2.5	2.7
Effect of charm vetoes	0.5	0.1	0.1	0.4	0.4	0.2
Shape fit components	1.8	0.3	0.5	0.4	0.5	1.9
Additional fit components	8.4	2.3	2.3	2.5	4.6	7.3
Normalisation of reflections in fit	0.2	0.0	0.1	0.4	0.7	1.7
Branching fraction of normalisation mode	6.9	6.9	6.9	6.9	6.9	6.9
f_d/f_s	-	-	-	5.8	5.8	5.8
Total systematic uncertainty	10.1	5.1	5.2	6.0	8.2	10.0
Statistical uncertainty	25.0	4.2	5.4	6.2	16.4	41.3