Studies of D_s^{**} spectroscopy with Dalitz plot analysis of $B_s^0 \to \overline{D}^0 K^- \pi^+$ decays

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on behalf of the LHCb collaboration

15th July 2014
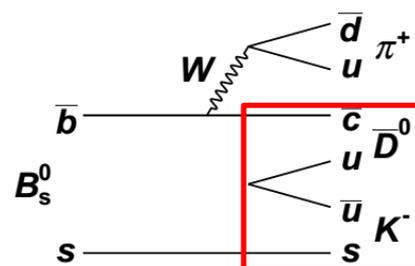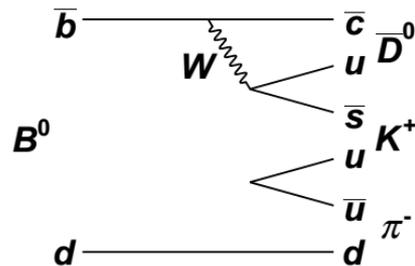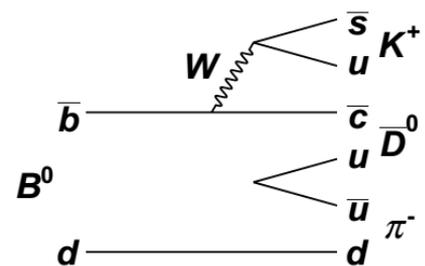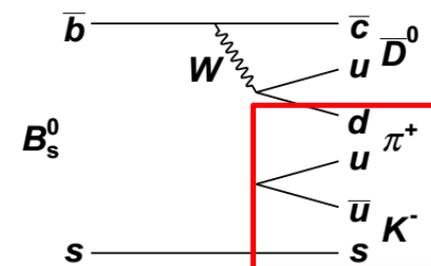
Beauty 2014
Edinburgh

Introduction

- Dalitz plot analysis is a powerful tool
  - Previously used by B-factories for charm spectroscopy
  - Not previously used for B_s^0 decays or D_s^{**} spectroscopy

- $B_s^0 \rightarrow \overline{D}^0 K^- \pi^+$ interesting for D_s^{**} spectroscopy and branching fraction measurements of two body B_s^0 decays

- Also a useful control channel for a Dalitz plot analysis of $B^0 \rightarrow D K^+ \pi^-$ which has potential to make a significant measurement of γ
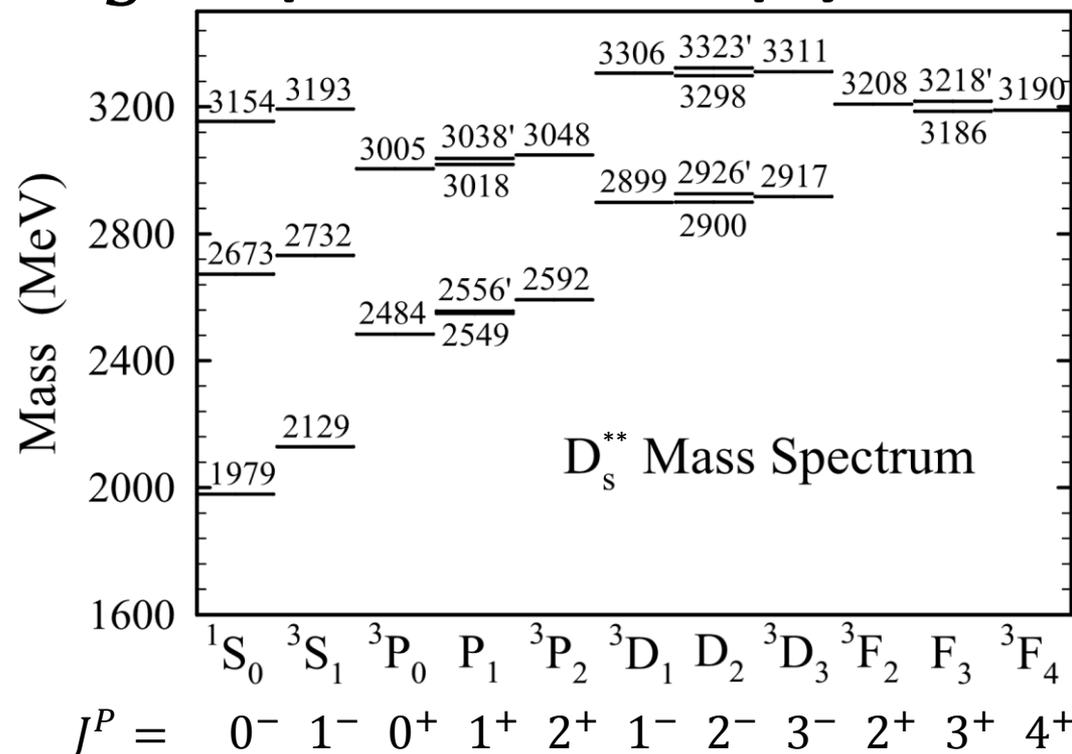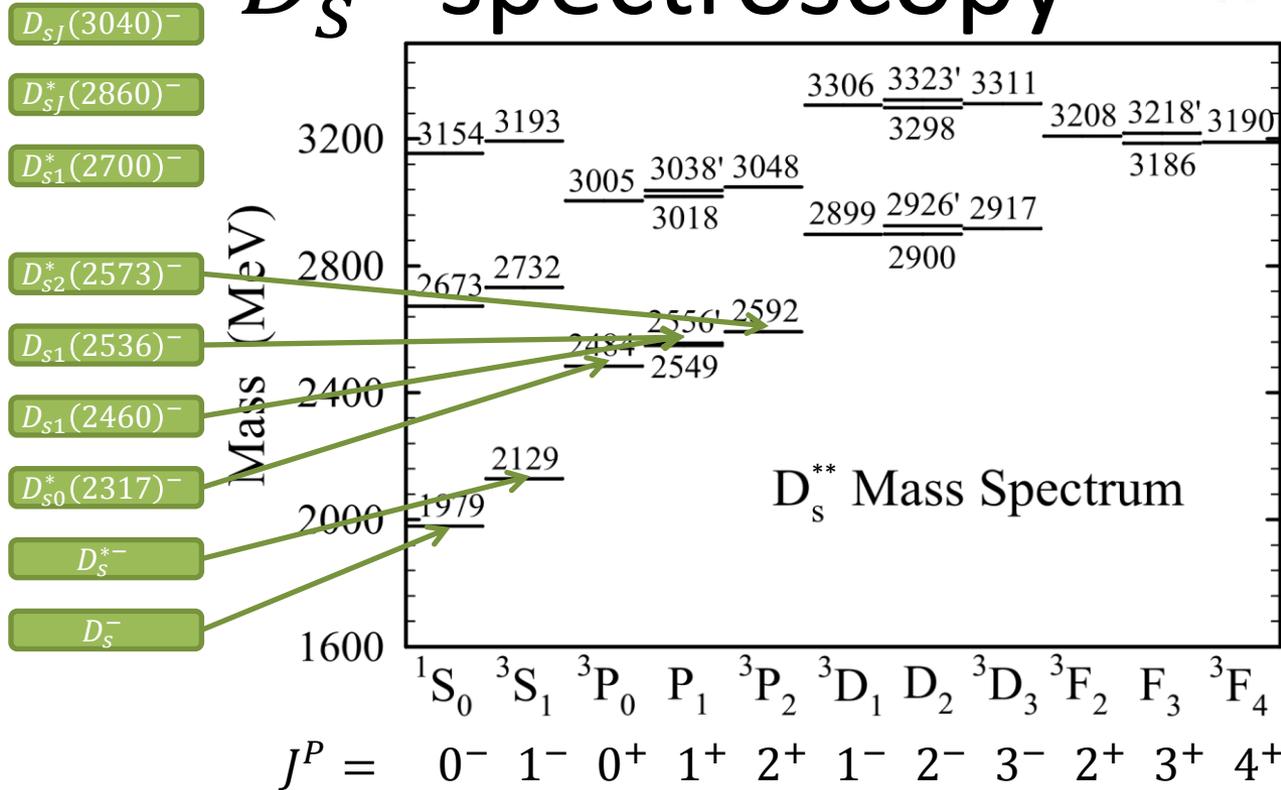

D_s^{**-}

K^{**0}

D_s^{**} spectroscopy

D_s^{**} Mass Spectrum

- Can use $B_s^0 \rightarrow D_s^{**-}(\rightarrow \overline{D}^0 K^-)\pi^+$ resonant contributions to probe D_s^{**} spectroscopy

D_s^{**} spectroscopy

$D_{sJ}(3040)^-$

$D_{sJ}^*(2860)^-$

$D_{s1}^*(2700)^-$

$D_{s2}^*(2573)^-$

$D_{s1}(2536)^-$

$D_{s1}(2460)^-$

$D_{s0}^*(2317)^-$

D_s^{*-}

D_s^-

D_s^{**} Mass Spectrum

$J^P = \quad 0^- \quad 1^- \quad 0^+ \quad 1^+ \quad 2^+ \quad 1^- \quad 2^- \quad 3^- \quad 2^+ \quad 3^+ \quad 4^+$

Some discrepancies between predicted and measured masses.

- Can use $B_s^0 \to D_s^{**-}(\to \overline{D}^0 K^-)\pi^+$ resonant contributions to probe D_s^{**} spectroscopy
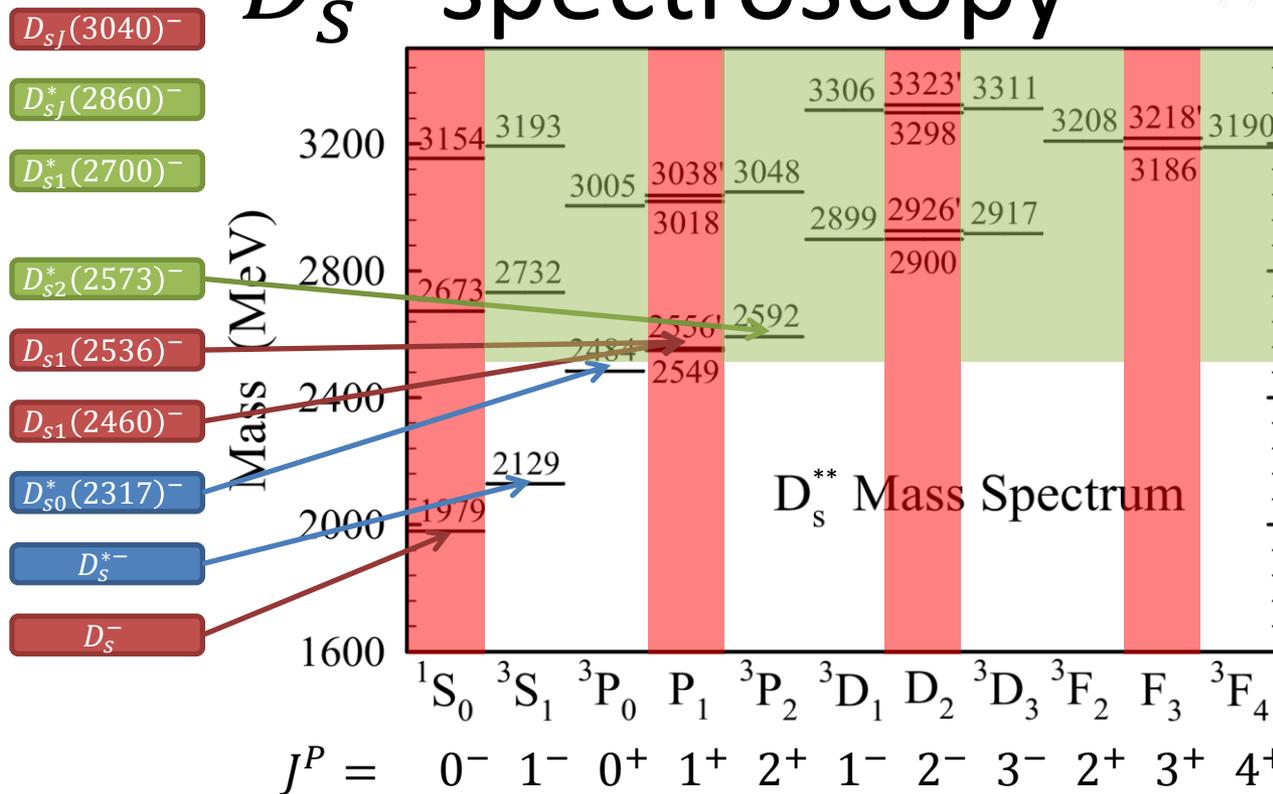
D_s^{**} spectroscopy

arXiv:1312.6181
Phys. Rev. D 89, 074023 (2014)

Some discrepancies between predicted and measured masses.

- Can use $B_s^0 \rightarrow D_s^{**-}(\rightarrow \overline{D}^0 K^-)\pi^+$ resonant contributions to probe D_s^{**} spectroscopy
- States with unnatural spin parity $(J^P = 0^-, 1^+, 2^- \dots)$ can not decay to $\overline{D}^0 K^-$, and D_s^{*-} and $D_{s0}^*(2317)^-$ are too light to decay to $\overline{D}^0 K^-$
- $D_{s2}^*(2573)^-$, $D_{s1}^*(2700)^-$ and $D_{sJ}^*(2860)^-$ are expected to contribute to $B_s^0 \rightarrow \overline{D}^0 K^- \pi^+$

Analysis overview

- Analysis of the resonance structure of $B_s \to \bar{D}^0 K^- \pi^+$
  - **New results!**
  - Perform fit using Laura++ package – http://laura.hepforge.org/
  - Use candidates with $\bar{D}^0 \to K^+ \pi^-$ from 3fb^{-1} of LHCb data

    LHCb-PAPER-2014-035, LHCb-PAPER-2014-036 (to be submitted to PRL and PRD)

- Branching fractions of $B_s^0 \to \bar{D}^0 K^- \pi^+$ and $B^0 \to \bar{D}^0 K^+ \pi^-$ have been measured as $(1.00 \pm 0.14) \times 10^{-3}$ and $(9.0 \pm 1.3) \times 10^{-5}$ respectively
  - Uncertainties dominated by the uncertainty on the normalisation channel

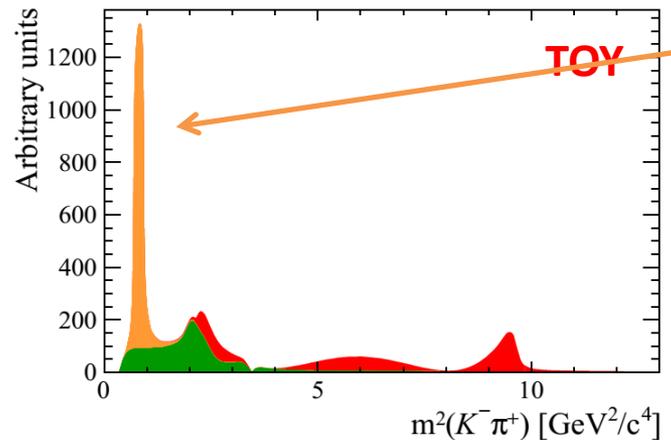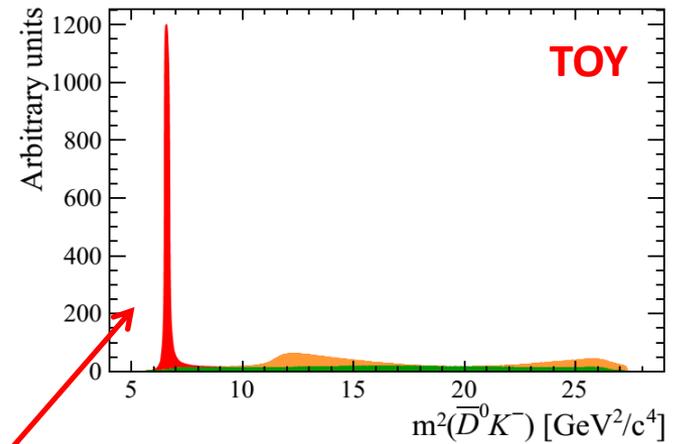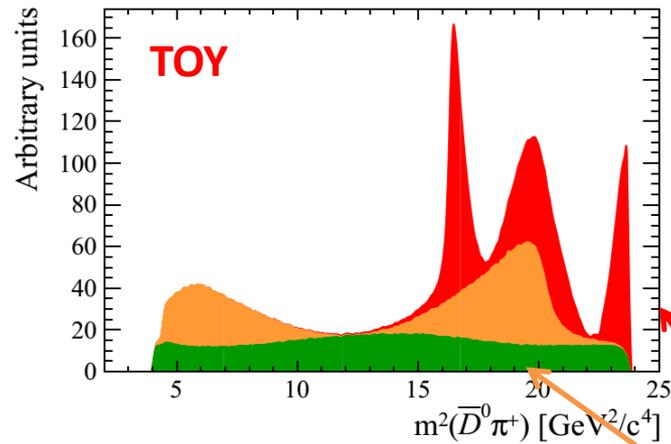   **Phys. Rev. D 87, 112009 (2013)**

The Dalitz plot
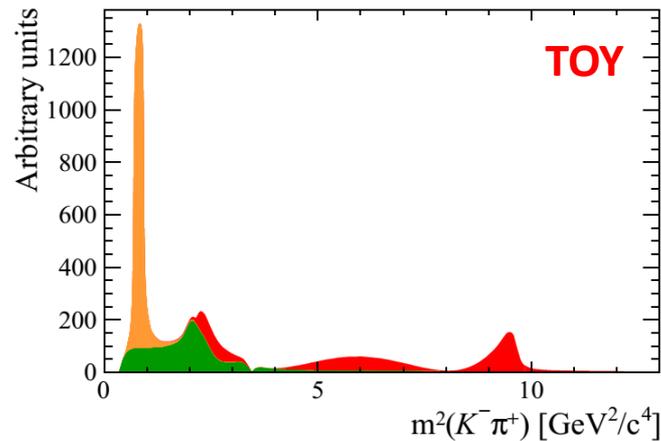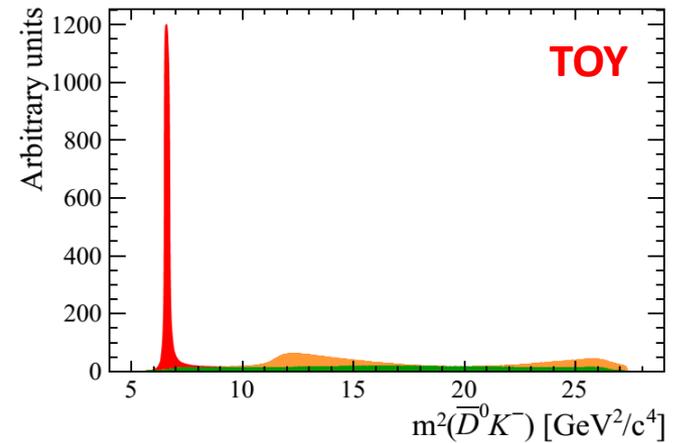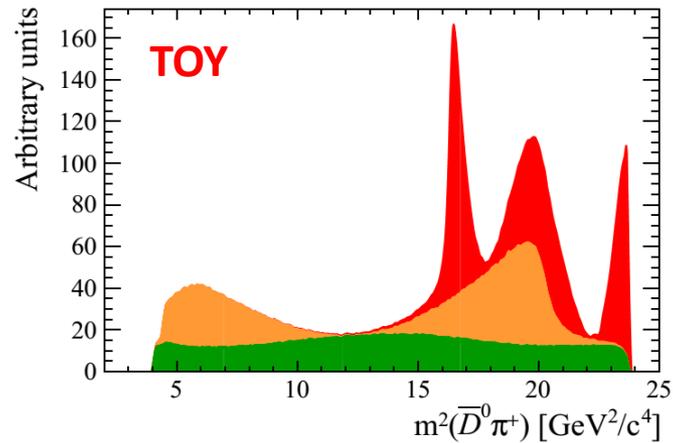
- See structures in the invariant masses of pairs of daughters

The Dalitz plot

$D_{s2}^*(2573)^-$ resonance in $m(DK)$
$\overline{K}^*(892)^0$ resonance in $m(K\pi)$

- See structures in the invariant masses of pairs of daughters
- Structures correspond to resonances in that pair of daughters or reflections from other resonances
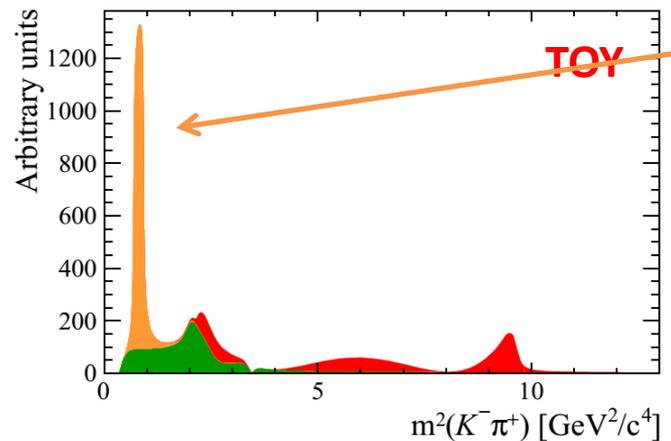
The Dalitz plot
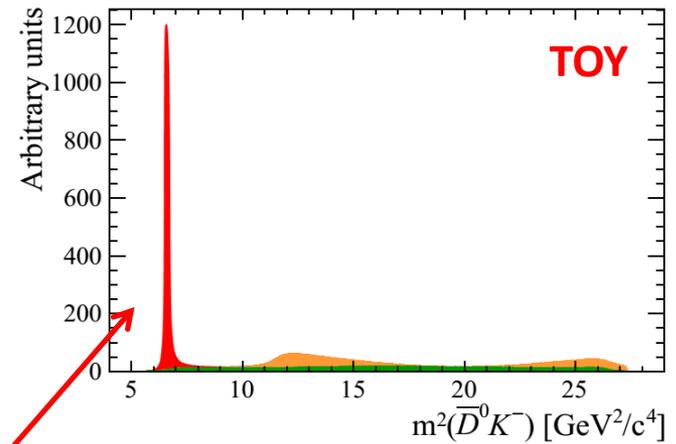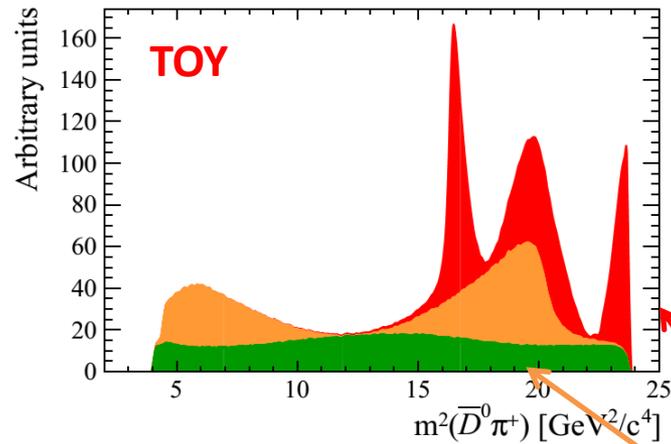
$D_{s2}^*(2573)^-$ resonance in $m(DK)$
$\overline{K}^*(892)^0$ resonance in $m(K\pi)$

- See structures in the invariant masses of pairs of daughters
- Structures correspond to resonances in that pair of daughters or reflections from other resonances
- Can use two invariant masses to plot in 2D…

The Dalitz plot
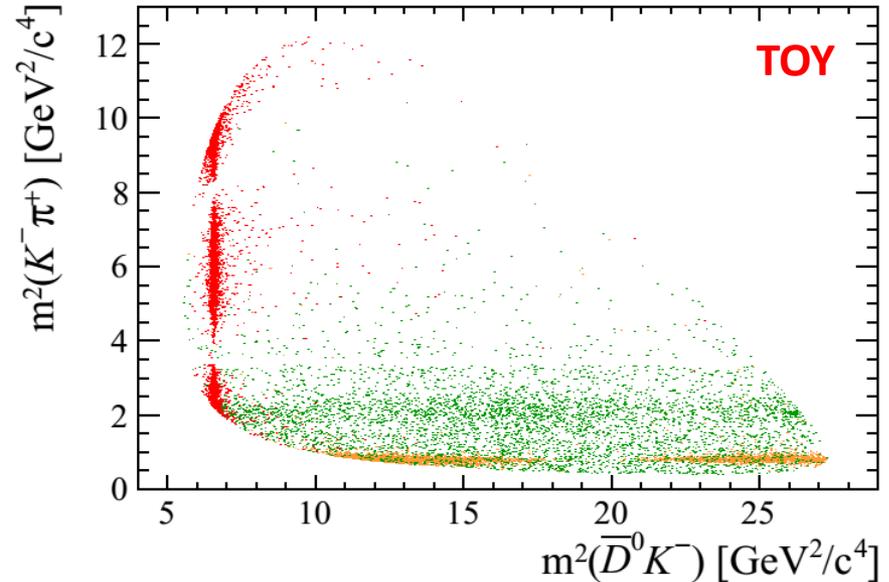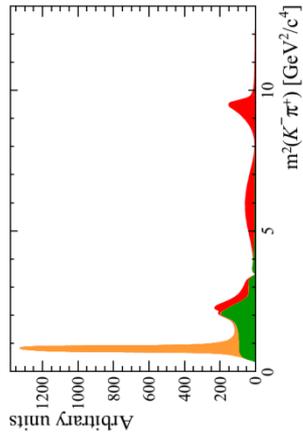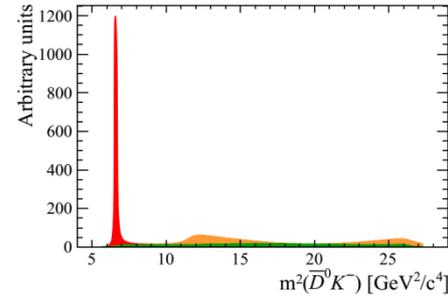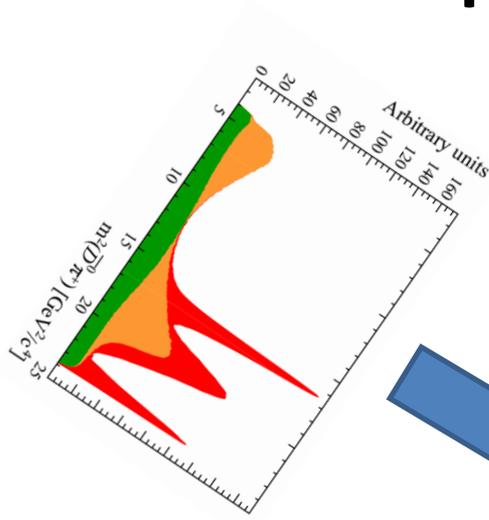
The (square) Dalitz plot
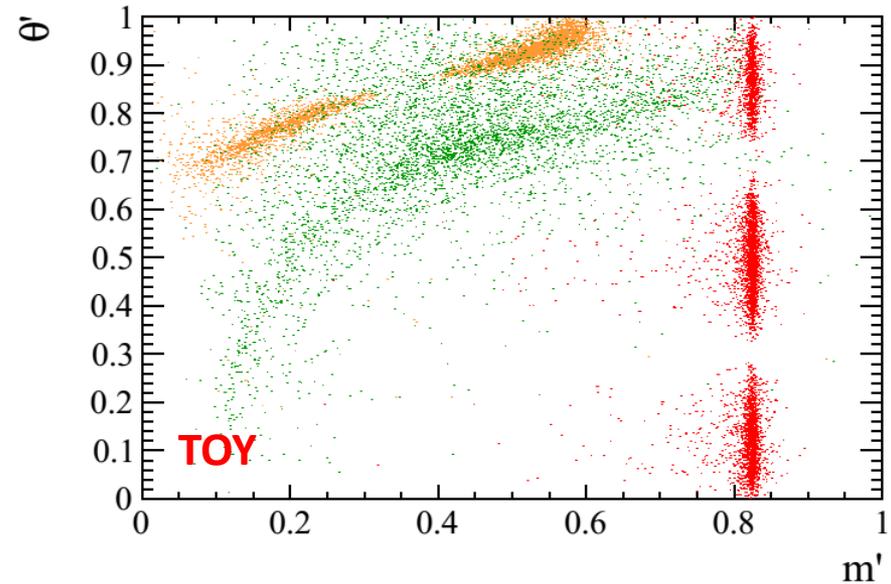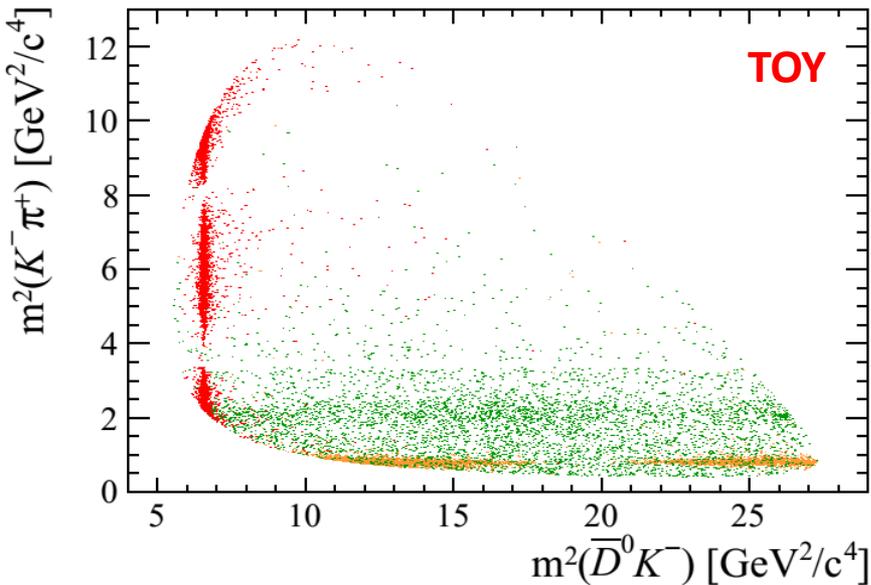
- For convenience we transform into different parameters that map the Dalitz plot to a square
- Plots show toy experiments including: $K^*(892)^0$, $K^*_{0,2}(1430)^0$ and $D^*_{s2}(2573)^-$
- m' is effectively m(DK) in reverse and θ' is the DK helicity angle

Fit to B mass
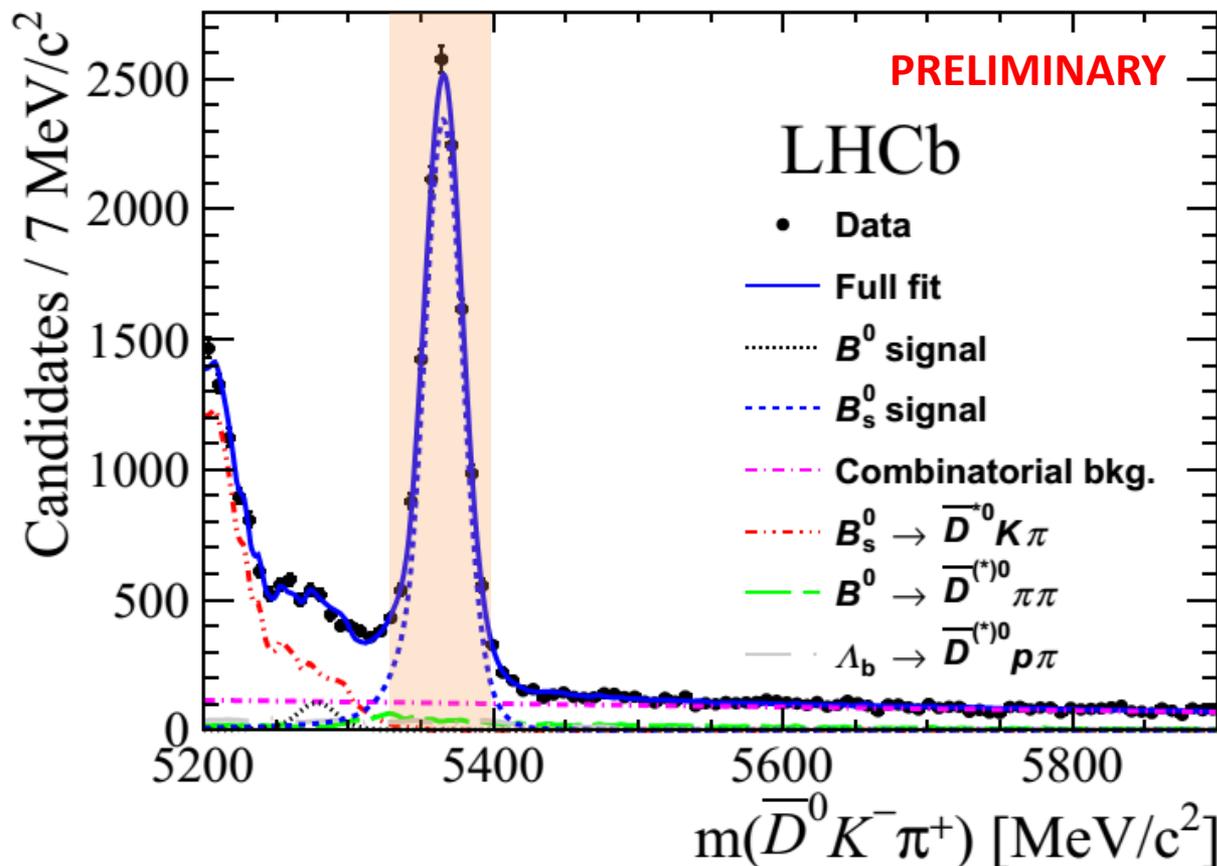
Fit to DKπ mass distribution from 3fb^{-1} of data showing the signal region ($\pm 2.5\sigma$). ~11,000 signal decays, 87% pure in the nominal signal window. Backgrounds due to combinatorial background (7.3%), $B^0 \to D^{(*)0}\pi\pi$ (2.8%) and $\Lambda_b \to D^{(*)0}p\pi$ (2.3%)

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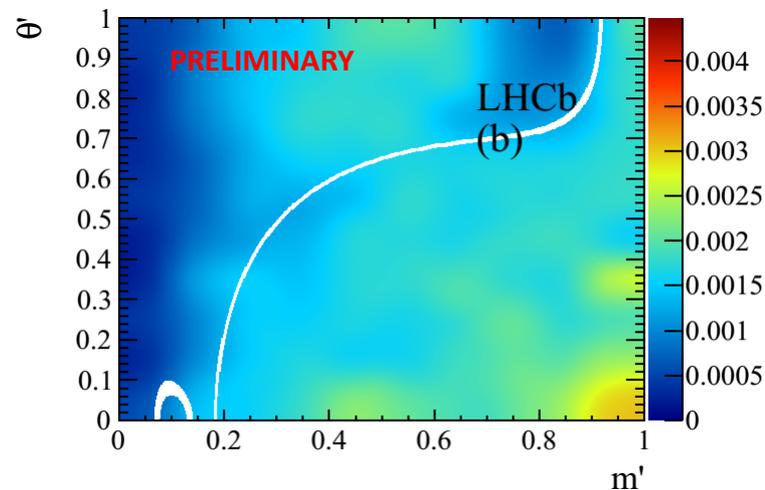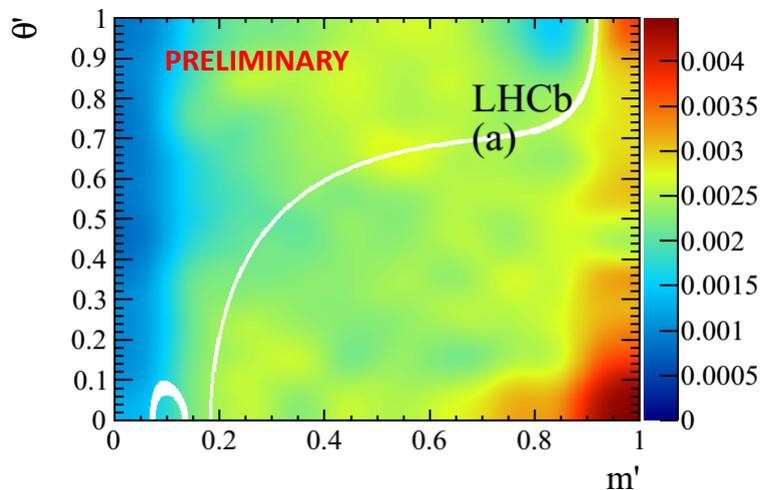
Efficiencies

Efficiency distributions for events (**a**) triggered by **particles in the candidate decay** and (**b**) **only** triggered by the **rest of the event**. White band running diagonally across the SDP caused by D^0 veto in $m(K\pi)$ and loop in bottom left corner caused by D^{*+} veto in $m(D\pi)$.

Backgrounds
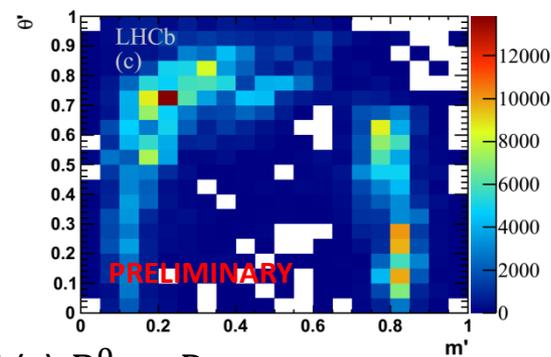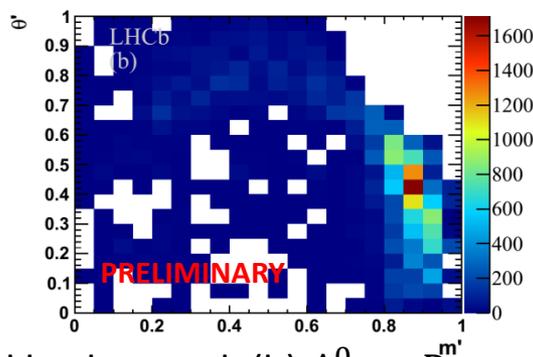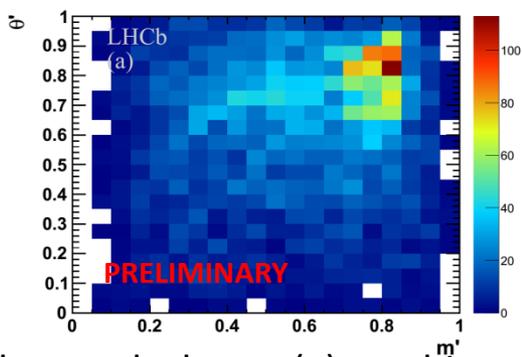
Backgrounds due to (a) combinatorial background, (b) $\Lambda_b^0 \to Dp\pi$ and (c) $B^0 \to D\pi\pi$

Dalitz plot fit

Resonance	Spin	Dalitz plot axis	Model	Parameters (MeV/c^2)
$\overline{K}^*(892)^0$	1	$m^2(K^-\pi^+)$	RBW	$m_0 = 895.81 \pm 0.19,\ \Gamma_0 = 47.4 \pm 0.6$
$\overline{K}^*(1410)^0$	1	$m^2(K^-\pi^+)$	RBW	$m_0 = 1414 \pm 15,\ \Gamma_0 = 232 \pm 21$
$\overline{K}_0^*(1430)^0$	0	$m^2(K^-\pi^+)$	LASS	Parameters floated
$\overline{K}_2^*(1430)^0$	2	$m^2(K^-\pi^+)$	RBW	$m_0 = 1432.4 \pm 1.3,\ \Gamma_0 = 109 \pm 5$
$\overline{K}^*(1680)^0$	1	$m^2(K^-\pi^+)$	RBW	$m_0 = 1717 \pm 27,\ \Gamma_0 = 322 \pm 110$
$\overline{K}_0^*(1950)^0$	0	$m^2(K^-\pi^+)$	RBW	$m_0 = 1945 \pm 22,\ \Gamma_0 = 201 \pm 90$
$D_{s2}^*(2573)^-$	2	$m^2(\overline{D}^0 K^-)$	RBW	Parameters floated
$D_{s1}^*(2700)^-$	1	$m^2(\overline{D}^0 K^-)$	RBW	$m_0 = 2709 \pm 4,\ \Gamma_0 = 117 \pm 13$
$D_{sJ}^*(2860)^-$	?	$m^2(\overline{D}^0 K^-)$	RBW	Parameters floated Multiple spin hypotheses tested
Nonresonant		$m^2(\overline{D}^0 K^-)$	EFF	Parameters floated
$D_{s\,v}^{*-}$	1	$m^2(\overline{D}^0 K^-)$	RBW	$m_0 = 2112.3 \pm 0.5$
$D_{s0\,v}^*(2317)^-$	0	$m^2(\overline{D}^0 K^-)$	RBW	$m_0 = 2317.8 \pm 0.6$
B_v^{*+}	1	$m^2(\overline{D}^0 \pi^+)$	RBW	$m_0 = 5325.2 \pm 0.4$

RBW = Relativistic Breit-Wigner, LASS = LASS $K\pi$ S-wave parameterisation, EFF = exponential form factor

Dalitz plot fit
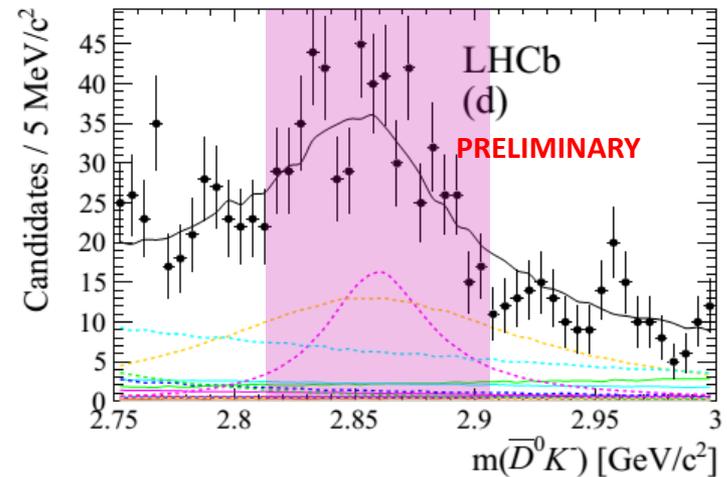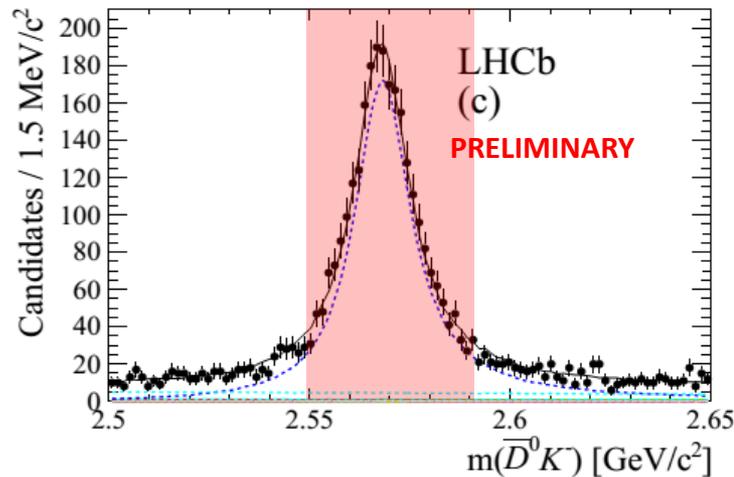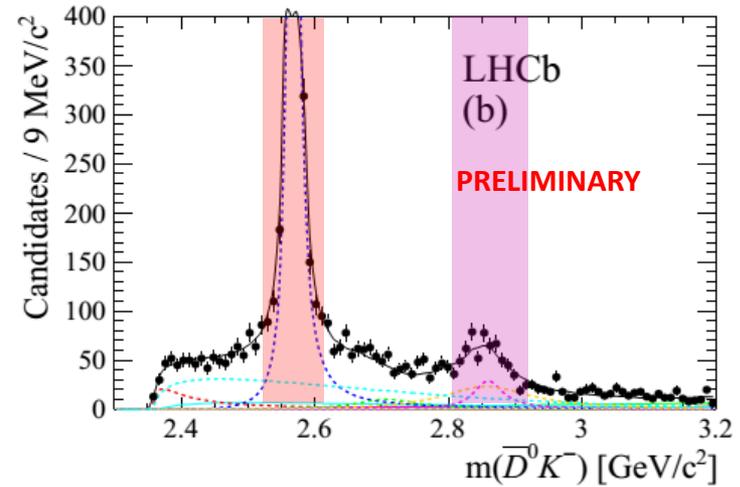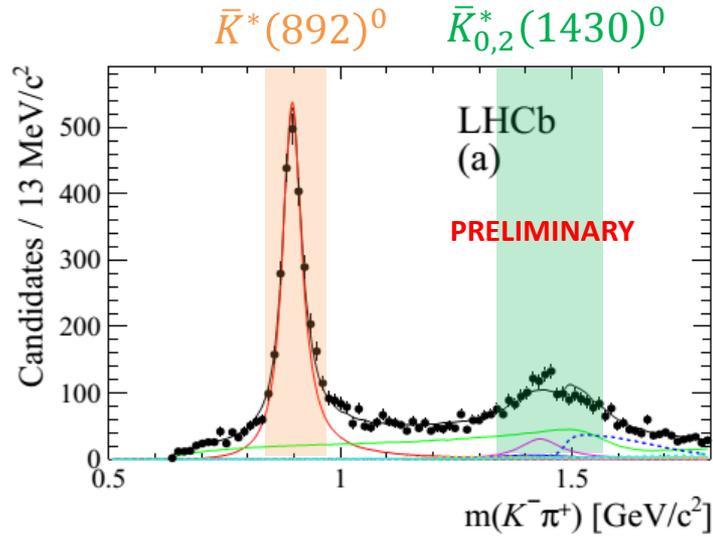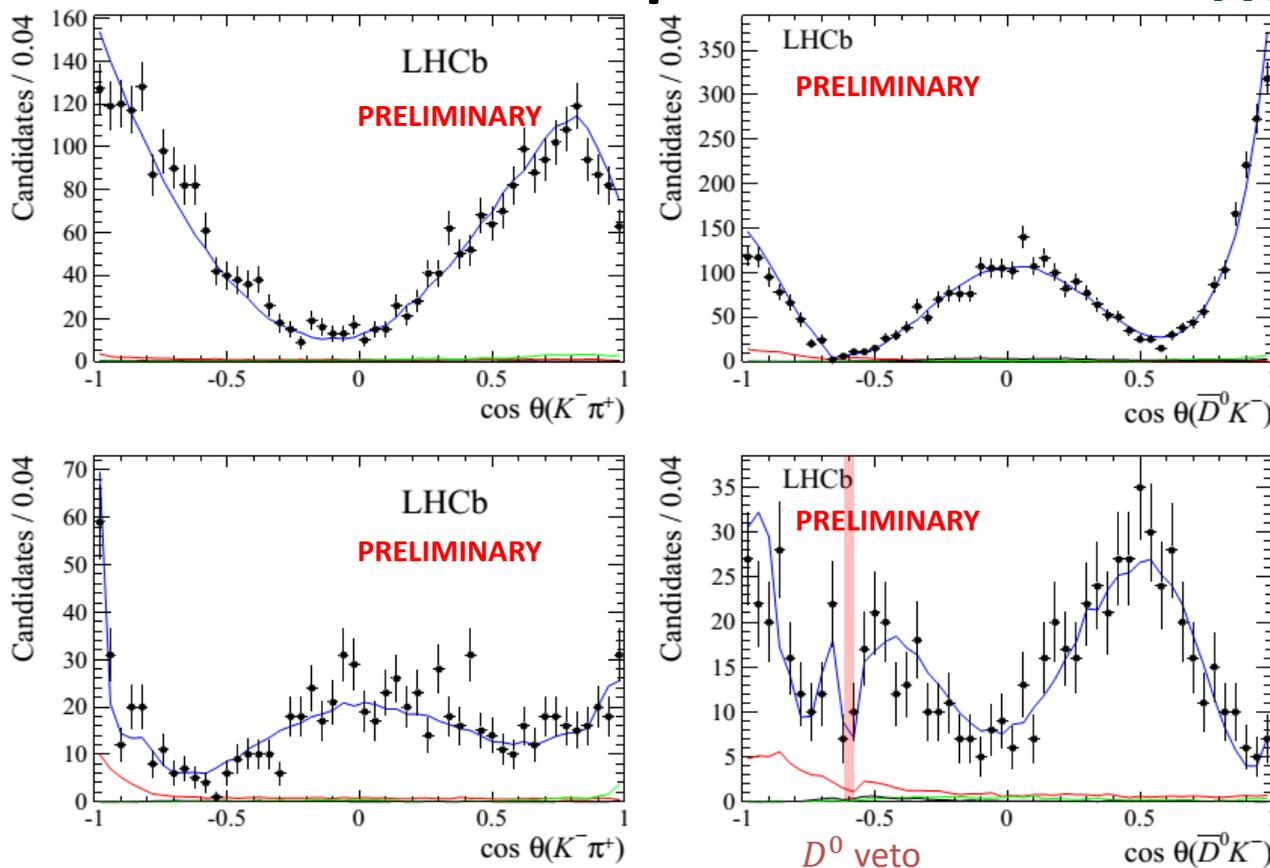
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$\bar{K}^*(892)^0$ $\bar{K}^*_{0,2}(1430)^0$

$D^*_{s2}(2573)^-$ $D^*_{sJ}(2860)^-$

Dalitz plot fit

- Slices of the helicity projections around the (top left) $\overline{K}^*(892)^0$ (top right) $D_{s2}^*(2573)^-$, (bottom left) $\overline{K}_{0,2}^*(1430)^0$ and (bottom right) $D_{sJ}^*(2860)^-$

- Helicity distributions depend on the spin of the resonances as well as reflections from resonances on another axis and efficiency effects

- Legendre moments also studied

Dalitz plot fit

vector
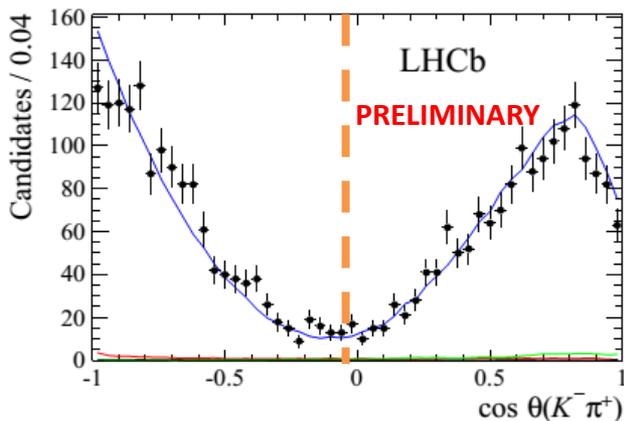
tensor
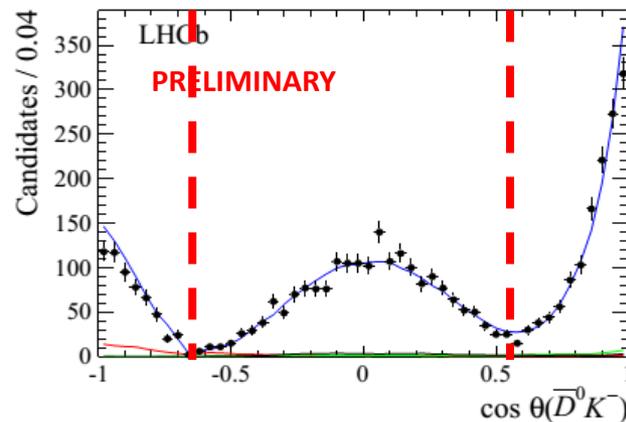
scalar + tensor
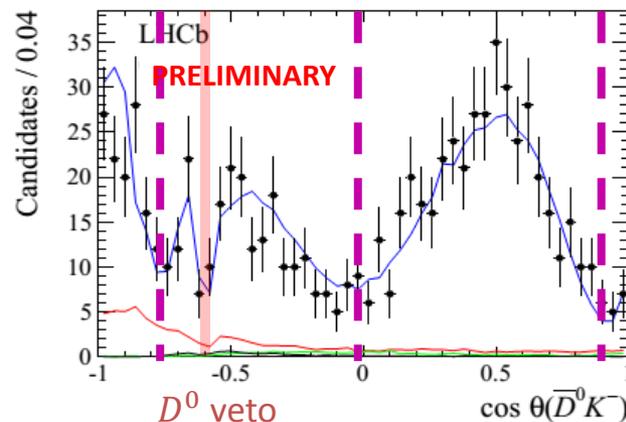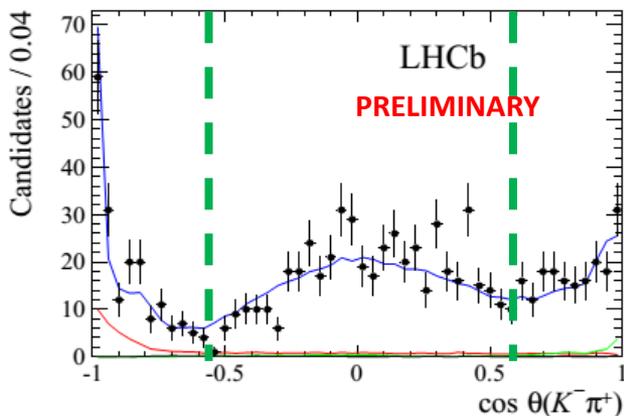
?

D^0 veto

- Slices of the helicity projections around the (top left) $\overline{K}^*(892)^0$ (top right) $D_{s2}^*(2573)^-$, (bottom left) $\overline{K}_{0,2}^*(1430)^0$ and (bottom right) $D_{sJ}^*(2860)^-$

- Helicity distributions depend on the spin of the resonances as well as reflections from resonances on another axis and efficiency effects

- Legendre moments also studied

$D^*_{sJ}(2860)^-$ states

- Various spin hypotheses tested for the $m_{DK} \approx 2.86\ \mathrm{GeV}/c^2$ region

- Spin-1 + spin-3 hypothesis offers best description of the data

- Spin-3 and spin-1 only hypotheses give poor descriptions of the DK helicity angle in the 2.86 GeV/c^2 region

χ^2 = 47.3, 214.0, 150.0
N_{bins} = 50
LHCb
PRELIMINARY

PRELIMINARY
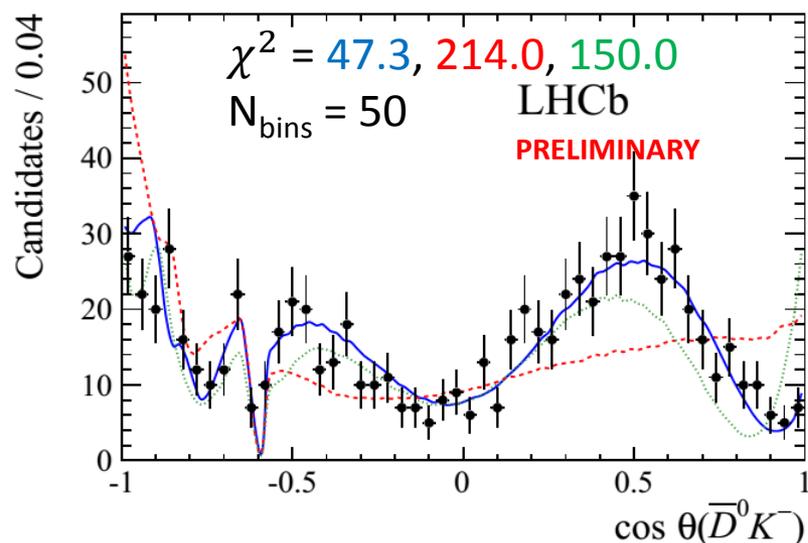
Spin hypothesis	ΔNLL	$\sqrt{2\Delta\mathrm{NLL}}$	Masses and widths			
1+3	0	—				
0	141.0	16.8	2862	57		
0+1	113.2	15.0	2446	250*	2855	96
0+2	155.1	17.6	2870	61	2569	17*
0+3	105.1	14.5	2415	188*	2860	52
1	156.8	17.7	2866	92		
1+2	138.6	16.6	2851	99	3134	174*
2	287.9	24.0	3243	81*		
2	365.5	27.0	2569	17*		
2+3	131.2	16.2	2878	12	2860	56
3	136.5	16.5	2860	57		

* Indicates states that floated out of the 2.86 GeV/c^2 region

$D_{sJ}^*(2860)^-$ states

- We obtain the $2\Delta LL$ distribution from toys generated without one of the $D_{sJ}^*(2860)^-$ states by fitting them with and without the missing state and extrapolate the tails to obtain p-values for the fit to data

- Nominal fits give significances of 14.8 (16.2) for the spin 1 (3) component

- Accounting for largest systematics still gives significances in excess of 10σ for both states
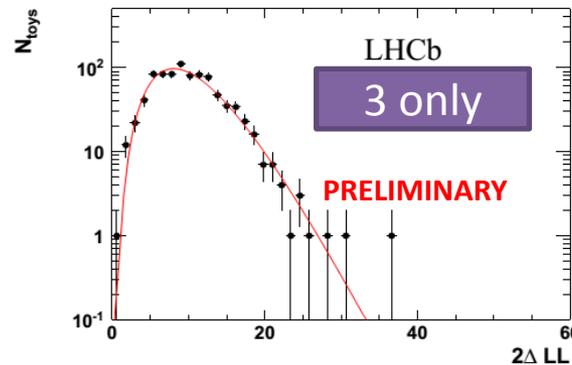
Value of 2ΔLL from fits to data = 273   314
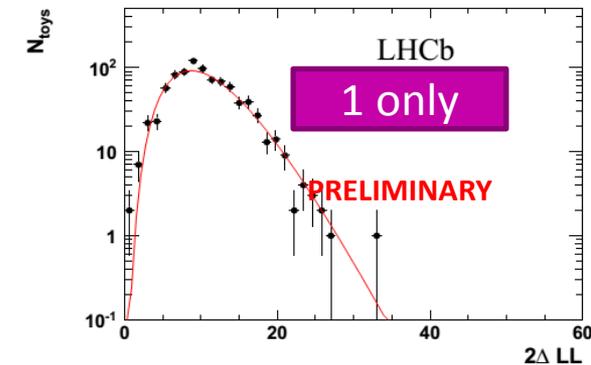
Systematics

Experimental

- **Efficiency**
- Backgrounds
- **Signal and background yields from mass fit**
- Fit bias
- Momentum scaling
- Masses of B_s^0 and D^0

Model

- Fixed parameters in fit
  - **Masses and widths**
  - Blatt-Weisskopf barrier factors
- Addition and removal of marginal components
- Alternative models
  - **$K\pi$ S-wave**
  - DK S-wave
  - DK P-wave
  - Virtual components

All quantities are affected different amounts by different systematics but the systematics that tend to dominate are in **red**.

Results

- Two states ($D_{s1}^*(2860)^-$ and $D_{s3}^*(2860)^-$) are required in the $m_{DK} \approx 2.86$ GeV/c^2 region, each with a significance of at least **10σ**

- Masses and widths measured for these two states and for the $D_{s2}^*(2573)^-$
  - $D_{s2}^*(2573)^-$ **mass and width** measurements are **far more precise** than previous measurements
  - mass is in some **contention** with the **PDG** (**3.5σ**)

- We also confirm the $D_{s2}^*(2573)^-$ to have $J^P = 2^+$ with a statistical significance of $\sim 40\sigma$
  - Previously universally assumed but unconfirmed   **PRELIMINARY**

$$
\begin{aligned}
m(D_{s2}^*(2573)^-) &= (2568.39 \pm 0.29\,(\text{stat}) \pm 0.19\,(\text{syst}) \pm 0.18\,(\text{model}))\,\text{MeV}/c^2\,, \\
\Gamma(D_{s2}^*(2573)^-) &= (16.9 \pm 0.5\,(\text{stat}) \pm 0.4\,(\text{syst}) \pm 0.4\,(\text{model}))\,\text{MeV}/c^2\,, \\
m(D_{s1}^*(2860)^-) &= (2859 \pm 12\,(\text{stat}) \pm 6\,(\text{syst}) \pm 23\,(\text{model}))\,\text{MeV}/c^2\,, \\
\Gamma(D_{s1}^*(2860)^-) &= (159 \pm 23\,(\text{stat}) \pm 27\,(\text{syst}) \pm 72\,(\text{model}))\,\text{MeV}/c^2\,, \\
m(D_{s3}^*(2860)^-) &= (2860.5 \pm 2.6\,(\text{stat}) \pm 2.5\,(\text{syst}) \pm 6.0\,(\text{model}))\,\text{MeV}/c^2\,, \\
\Gamma(D_{s3}^*(2860)^-) &= (53 \pm 7\,(\text{stat}) \pm 4\,(\text{syst}) \pm 6\,(\text{model}))\,\text{MeV}/c^2\,,
\end{aligned}
$$

Results

- Product branching fractions $\mathcal{B}(B \to Rc) \times \mathcal{B}(R \to ab)$ are reported for all fit components.

- For resonances where the subsequent branching fraction is known we also report two-body branching fractions $\mathcal{B}(B \to Rc)$

- $\mathcal{B}(B_s^0 \to \overline{D}^0 \overline{K}^*(892)^0)$ is consistent with LHCb measurement based on 0.37pb^{-1}

- Other branching fractions are first measurements

Resonance R	Product branching fraction (10^{-5})	Branching fraction (10^{-4})
$\overline{K}^*(892)^0$	$28.6 \pm 0.6 \pm 0.7 \pm 0.9 \pm 4.2$	$4.29 \pm 0.09 \pm 0.11 \pm 0.14 \pm 0.63$
$\overline{K}^*(1410)^0$	$1.7 \pm 0.5 \pm 0.2 \pm 1.4 \pm 0.2$	$3.86 \pm 1.14 \pm 0.45 \pm 3.18 \pm 0.89$
LASS nonresonant	$13.7 \pm 2.5 \pm 1.5 \pm 4.1 \pm 2.0$	$2.06 \pm 0.38 \pm 0.23 \pm 0.62 \pm 0.30$
$\overline{K}_0^*(1430)^0$	$20.0 \pm 1.6 \pm 0.7 \pm 3.3 \pm 2.9$	$3.00 \pm 0.24 \pm 0.11 \pm 0.50 \pm 0.44$
LASS total	$21.4 \pm 1.4 \pm 1.0 \pm 4.7 \pm 3.1$	$3.21 \pm 0.21 \pm 0.15 \pm 0.71 \pm 0.47$
$\overline{K}_2^*(1430)^0$	$3.7 \pm 0.6 \pm 0.4 \pm 1.1 \pm 0.5$	$1.11 \pm 0.18 \pm 0.12 \pm 0.33 \pm 0.15$
$D_{s2}^*(2573)^-$	$25.7 \pm 0.7 \pm 0.8 \pm 1.1 \pm 3.8$	
$D_{s1}^*(2700)^-$	$1.6 \pm 0.4 \pm 0.4 \pm 0.5 \pm 0.2$	**PRELIMINARY**
$D_{s1}^*(2860)^-$	$5.0 \pm 1.2 \pm 0.7 \pm 3.3 \pm 0.7$	
$D_{s3}^*(2860)^-$	$2.2 \pm 0.1 \pm 0.3 \pm 0.4 \pm 0.3$	

Uncertainties are stat, syst, model and PDG

Results

- For insignificant fit components we report upper limits on the two-body branching fractions.

- We scan the fit fraction to construct a likelihood function and smear this with a Gaussian to account for systematics.

- The upper limit is then defined by integrating the smeared likelihood function in the positive region.

$$\mathcal{B}(B_s^0 \to \overline{D}^0 \overline{K}^*(1680)^0) \quad < \quad 7.8 \, (9.3) \times 10^{-5} \text{ at } 90\% \, (95\%) \text{ CL},$$

$$\mathcal{B}(B_s^0 \to \overline{D}^0 \overline{K}_0^*(1950)^0) \quad < \quad 10.7 \, (11.8) \times 10^{-5} \text{ at } 90\% \, (95\%) \text{ CL},$$

$$\mathcal{B}(B_s^0 \to \overline{D}^0 \overline{K}_3^*(1780)^0) \quad < \quad 2.6 \, (3.0) \times 10^{-5} \text{ at } 90\% \, (95\%) \text{ CL},$$

$$\mathcal{B}(B_s^0 \to \overline{D}^0 \overline{K}_4^*(2045)^0) \quad < \quad 3.1 \, (3.6) \times 10^{-5} \text{ at } 90\% \, (95\%) \text{ CL}.$$

PRELIMINARY

Summary

- First observation of a heavy flavoured spin-3 state and the first observation of a spin-3 state in a B decay

- Previously seen $D_{sJ}^*(2860)^-$ has been resolved into two separate resonances
  - Consistent with being the two natural parity members of the 1D family of D_s^{**} states

- The mass and width of the $D_{s2}^*(2573)^-$ have been measured more precisely than the current PDG average
  - Spin-2 confirmed

- Product branching fractions have been reported for all of the components in the Dalitz plot fit
  - Two-body branching fractions have been reported for the B_s^0 decays to resonances where the branching fraction of the resonance decay is known

LHCb-PAPER-2014-035, LHCb-PAPER-2014-036

BACKUP

The LHCb detector
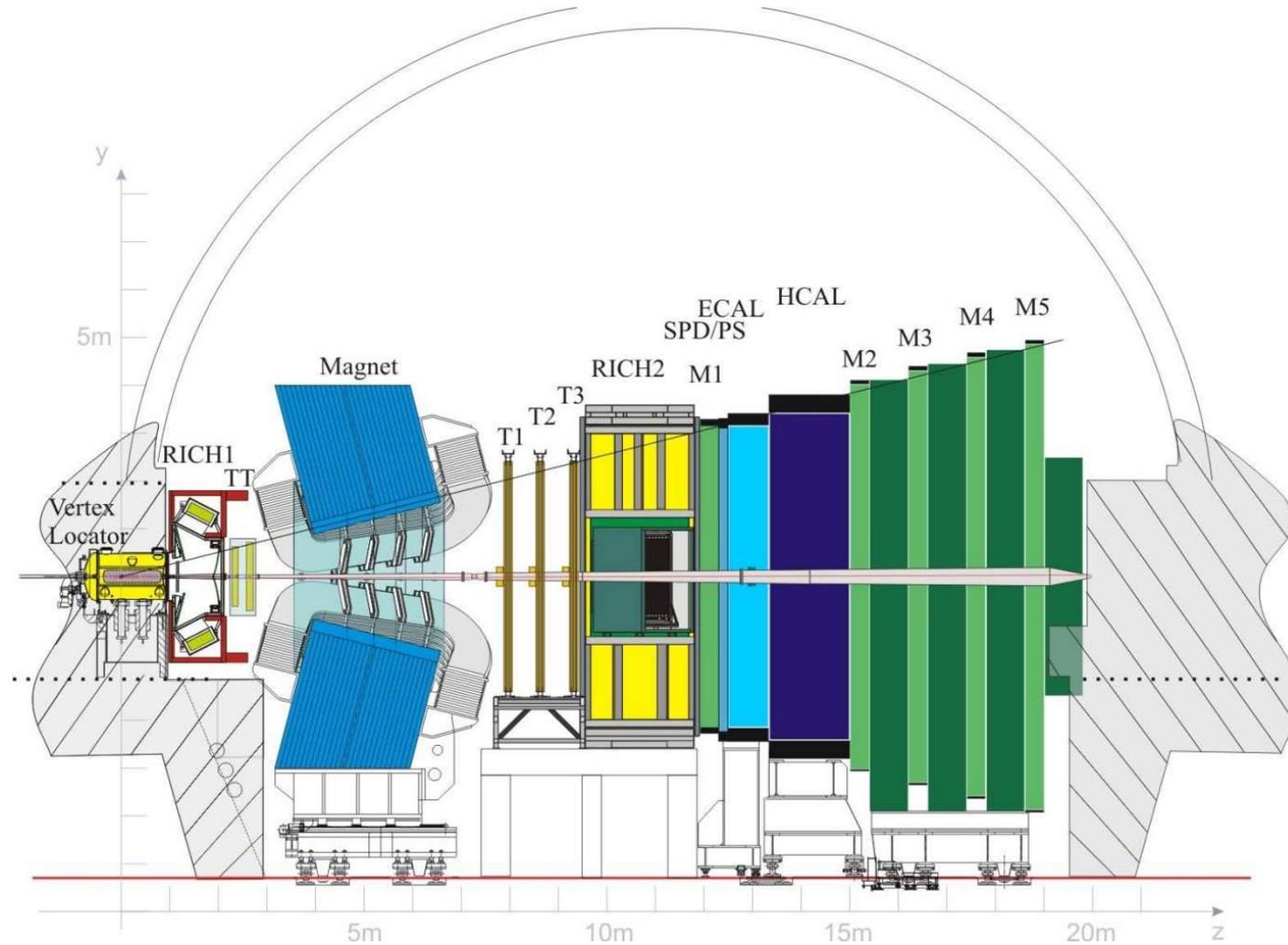
Recorded Luminosity
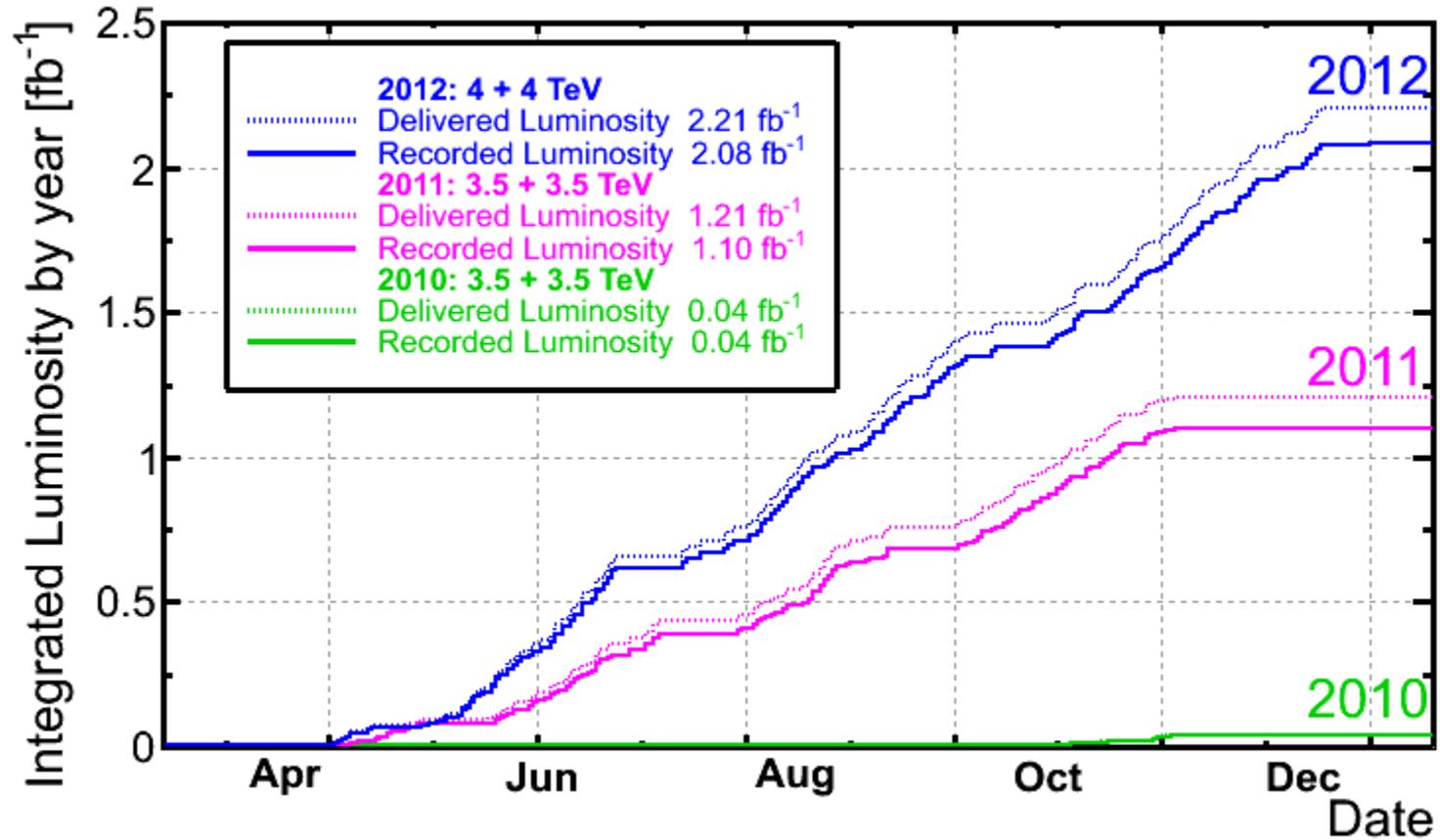
Kaon/pion separation

- Most particle identification information comes from the Ring Imaging Cherenkov detectors.
- Three different radiators provide separation over a wide momentum range.

$$\cos\theta = \frac{1}{\beta n}$$
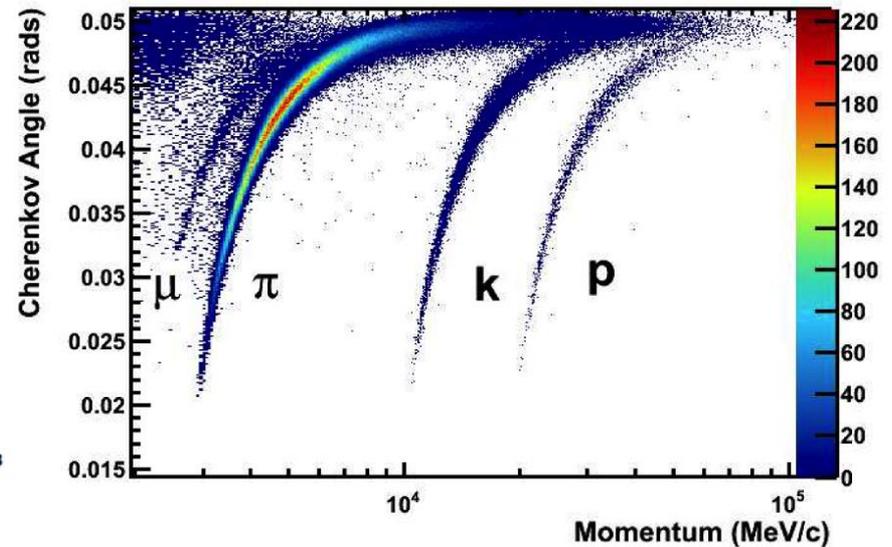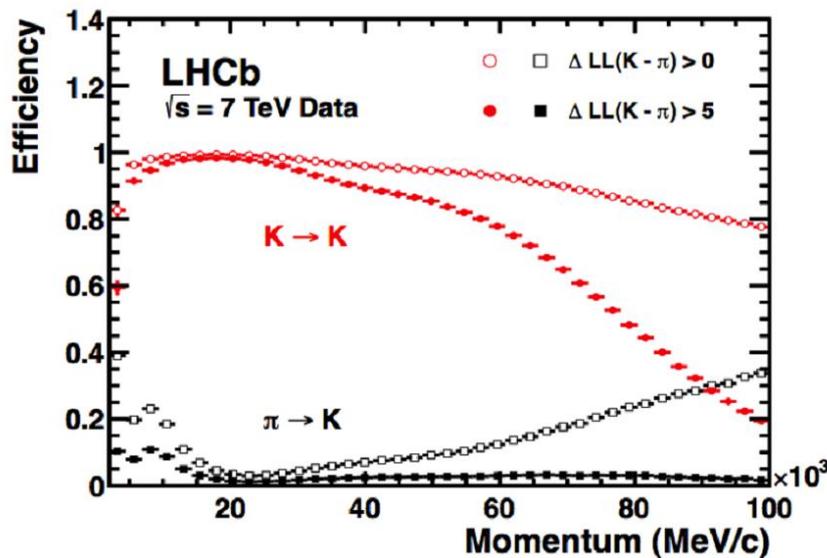
Trigger categories
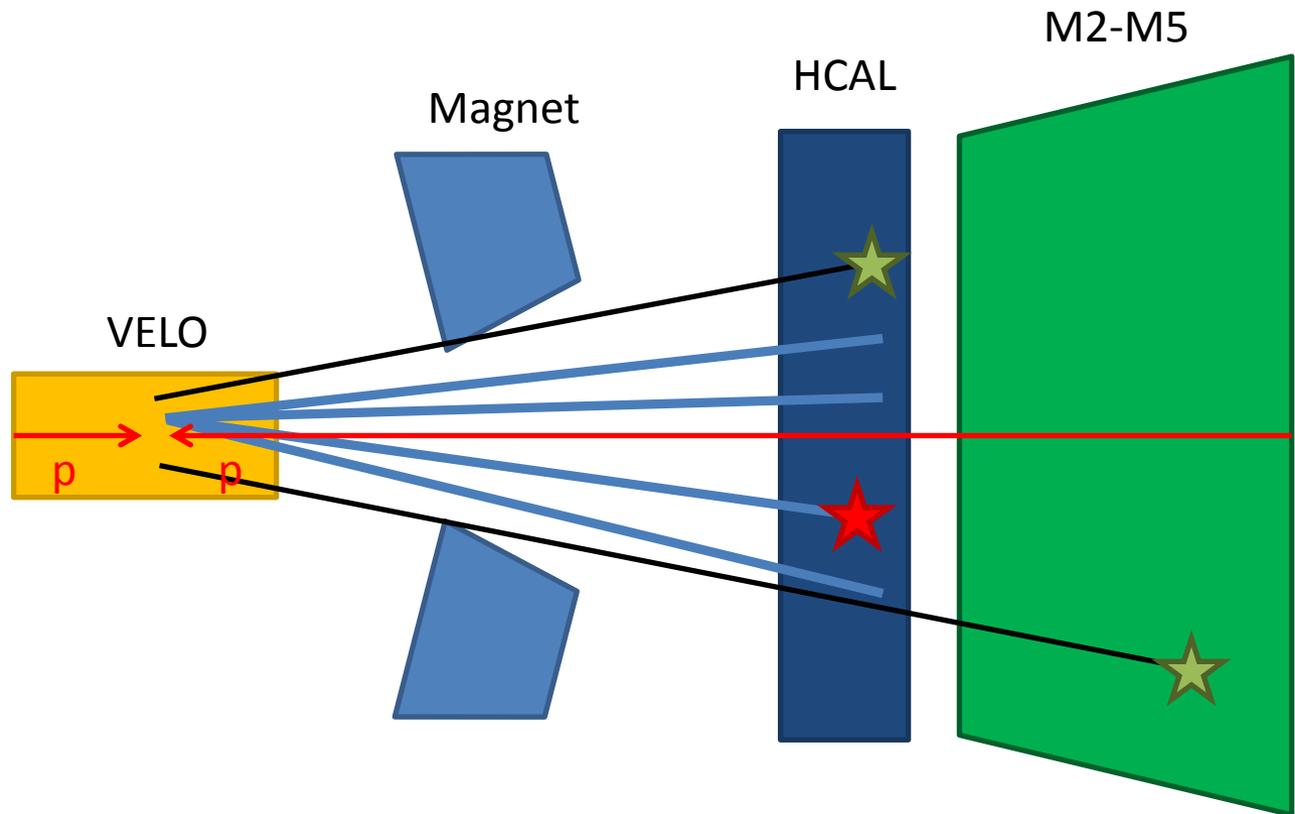
Trigger On Signal
- Particle from the signal decay fires a trigger line.
- Triggered by HCAL deposits.

Trigger Independent of Signal
- Particle from the rest of the event fires a trigger line.
- Triggered mostly by HCAL deposits or muons.

Selection

- Loose initial requirements are imposed to obtain a visible signal peak in the $B^0 \to \overline{D}^0 \pi^+ \pi^-$ control channel.
- This control channel is used to train a neural network to reject combinatorial background events.
  - The *sPlot* technique is used to statistically separate signal from background in the B^0 candidate mass.
  - Reduces combinatoric background by a factor 5 while retaining >90% of signal
 - Variables include: A boosted decision tree that selects for $X_b \to \overline{D}^0 (\to K^+ \pi^-) X$ decays; the χ^2_{IP} of the four final state particles; the χ^2_{IP}, χ^2_{vertex}, χ^2_{flight} and $\cos \theta_{\text{dir}}$ of the $\overline{D}^0$; the p_T, χ^2_{IP}, χ^2_{vertex}, χ^2_{flight} and $\cos \theta_{\text{dir}}$ of the B; the p_T asymmetry and track multiplicity in a cone around the flight direction of the B candidate
- The four final tracks are also required to satisfy particle identification requirements.
- Requirements are made to remove peaking backgrounds from $B_s^0 \to D^0 \overline{D}^0$, $B_s^0 \to D_s^- \pi^+$, $B_s^0 \to J/\psi K^{*0}$ and $B_s^0 \to D^{*-} K^+$.

Data DP distribution
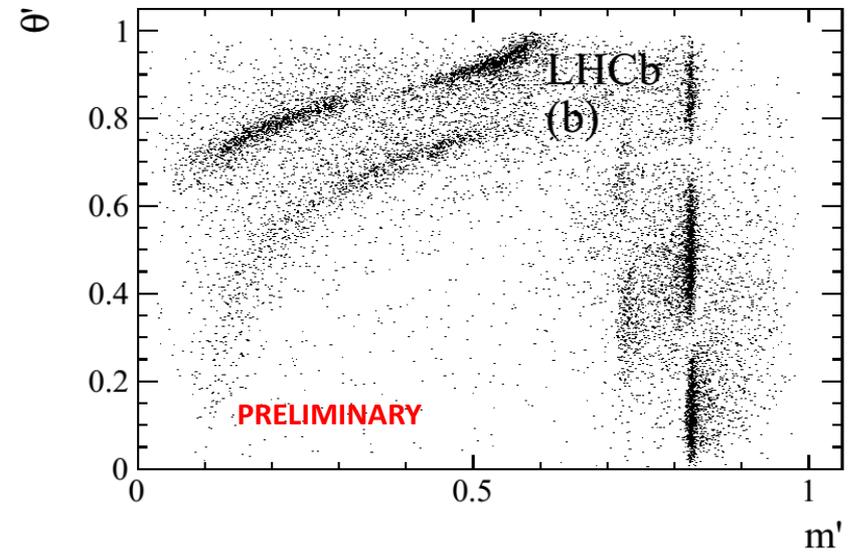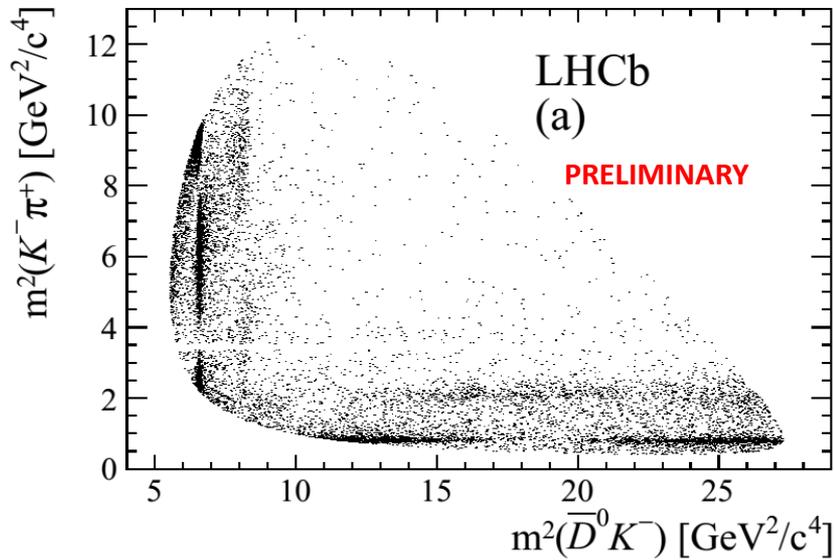
Distribution of candidates in (a) the Dalitz plot and (b) the square Dalitz plot.

Fit parameters

| Resonance	Real part	Imaginary part	Magnitude	Phase
$\overline{K}^*(892)^0$	$-0.75\pm0.08\pm0.16\pm0.72$	$0.74\pm0.08\pm0.13\pm0.33$	$1.06\pm0.02\pm0.03\pm0.03$	$2.36\pm0.13\pm0.20\pm0.76$
$\overline{K}^*(1410)^0$	$-0.25\pm0.03\pm0.02\pm0.15$	$-0.04\pm0.05\pm0.12\pm0.22$	$0.25\pm0.04\pm0.02\pm0.14$	$-2.96\pm0.21\pm0.50\pm1.09$
LASS nonresonant	$-0.43\pm0.09\pm0.16\pm0.14$	$0.59\pm0.06\pm0.06\pm0.18$	$0.73\pm0.06\pm0.05\pm0.11$	$2.19\pm0.16\pm0.26\pm0.26$
$\overline{K}_0^*(1430)^0$	$-0.49\pm0.10\pm0.22\pm0.14$	$0.73\pm0.07\pm0.07\pm0.08$	$0.88\pm0.04\pm0.03\pm0.07$	$2.16\pm0.20\pm0.25\pm0.16$
$\overline{K}_2^*(1430)^0$	$0.09\pm0.05\pm0.08\pm0.26$	$-0.37\pm0.03\pm0.02\pm0.03$	$0.38\pm0.03\pm0.02\pm0.05$	$-1.34\pm0.10\pm0.20\pm0.65$
$\overline{K}^*(1680)^0$	$-0.08\pm0.04\pm0.06\pm0.14$	$0.12\pm0.04\pm0.02\pm0.20$	$0.14\pm0.06\pm0.04\pm0.11$	$2.16\pm0.26\pm0.32\pm2.66$
$\overline{K}_0^*(1950)^0$	$0.11\pm0.03\pm0.03\pm0.21$	$-0.01\pm0.04\pm0.04\pm0.23$	$0.11\pm0.04\pm0.03\pm0.22$	$-0.09\pm0.41\pm0.32\pm1.71$
$D_{s2}^*(2573)^-$	1.00	0.00	1.00	0.00
$D_{s1}^*(2700)^-$	$-0.22\pm0.04\pm0.02\pm0.06$	$-0.13\pm0.04\pm0.06\pm0.13$	$0.25\pm0.04\pm0.03\pm0.04$	$-2.61\pm0.17\pm0.18\pm0.53$
$D_{s1}^*(2860)^-$	$-0.41\pm0.05\pm0.05\pm0.24$	$0.16\pm0.06\pm0.05\pm0.09$	$0.44\pm0.05\pm0.03\pm0.17$	$2.78\pm0.20\pm0.12\pm0.52$
$D_{s3}^*(2860)^-$	$0.27\pm0.02\pm0.03\pm0.05$	$-0.12\pm0.03\pm0.02\pm0.04$	$0.29\pm0.02\pm0.02\pm0.03$	$-0.42\pm0.07\pm0.10\pm0.18$
Nonresonant	$0.58\pm0.07\pm0.25\pm0.28$	$-0.39\pm0.06\pm0.04\pm0.28$	$0.70\pm0.08\pm0.15\pm0.19$	$-0.59\pm0.10\pm0.36\pm0.48$
D_{sv}^{*-}	$0.36\pm0.04\pm0.04\pm0.18$	$0.23\pm0.05\pm0.05\pm0.17$	$0.43\pm0.05\pm0.05\pm0.16$	$0.57\pm0.12\pm0.08\pm0.43$
$D_{s0v}^*(2317)^-$	$0.18\pm0.08\pm0.22\pm0.18$	$0.24\pm0.04\pm0.05\pm0.09$	$0.30\pm0.06\pm0.16\pm0.13$	$0.91\pm0.21\pm0.72\pm0.43$
B_v^{*+}	$-0.09\pm0.10\pm0.08\pm0.25$	$-0.26\pm0.05\pm0.11\pm0.31$	$0.27\pm0.09\pm0.06\pm0.13$	$-1.90\pm0.40\pm0.34\pm1.53$

PRELIMINARY

Fit parameters

Resonance	Fit fraction
$\overline{K}^*(892)^0$	$28.6 \pm 0.6 \pm 0.7 \pm 0.9$
$\overline{K}^*(1410)^0$	$1.7 \pm 0.5 \pm 0.2 \pm 1.4$
LASS nonresonant	$13.7 \pm 2.5 \pm 1.5 \pm 4.1$
$\overline{K}_0^*(1430)^0$	$20.0 \pm 1.6 \pm 0.7 \pm 3.3$
LASS total	$21.4 \pm 1.4 \pm 1.0 \pm 4.7$
$\overline{K}_2^*(1430)^0$	$3.7 \pm 0.6 \pm 0.4 \pm 1.1$
$\overline{K}^*(1680)^0$	$0.5 \pm 0.4 \pm 0.3 \pm 0.8$
$\overline{K}_0^*(1950)^0$	$0.3 \pm 0.2 \pm 0.1 \pm 2.4$
$D_{s2}^*(2573)^-$	$25.7 \pm 0.7 \pm 0.8 \pm 1.1$
$D_{s1}^*(2700)^-$	$1.6 \pm 0.4 \pm 0.4 \pm 0.5$
$D_{s1}^*(2860)^-$	$5.0 \pm 1.2 \pm 0.7 \pm 3.3$
$D_{s3}^*(2860)^-$	$2.2 \pm 0.1 \pm 0.3 \pm 0.4$
Nonresonant	$12.4 \pm 2.7 \pm 4.3 \pm 7.6$
D_{sv}^{*-}	$4.7 \pm 1.4 \pm 1.1 \pm 4.0$
$D_{s0v}^*(2317)^-$	$2.3 \pm 1.1 \pm 1.9 \pm 2.3$
B_v^{*+}	$1.9 \pm 1.2 \pm 1.1 \pm 1.8$

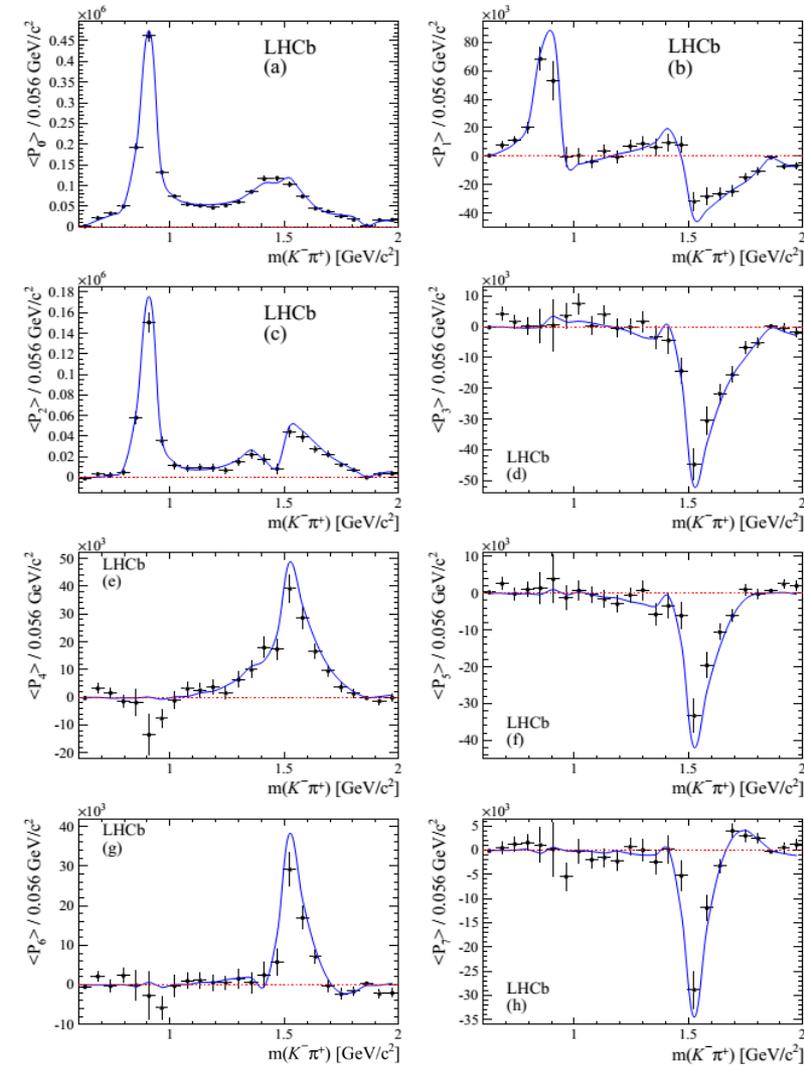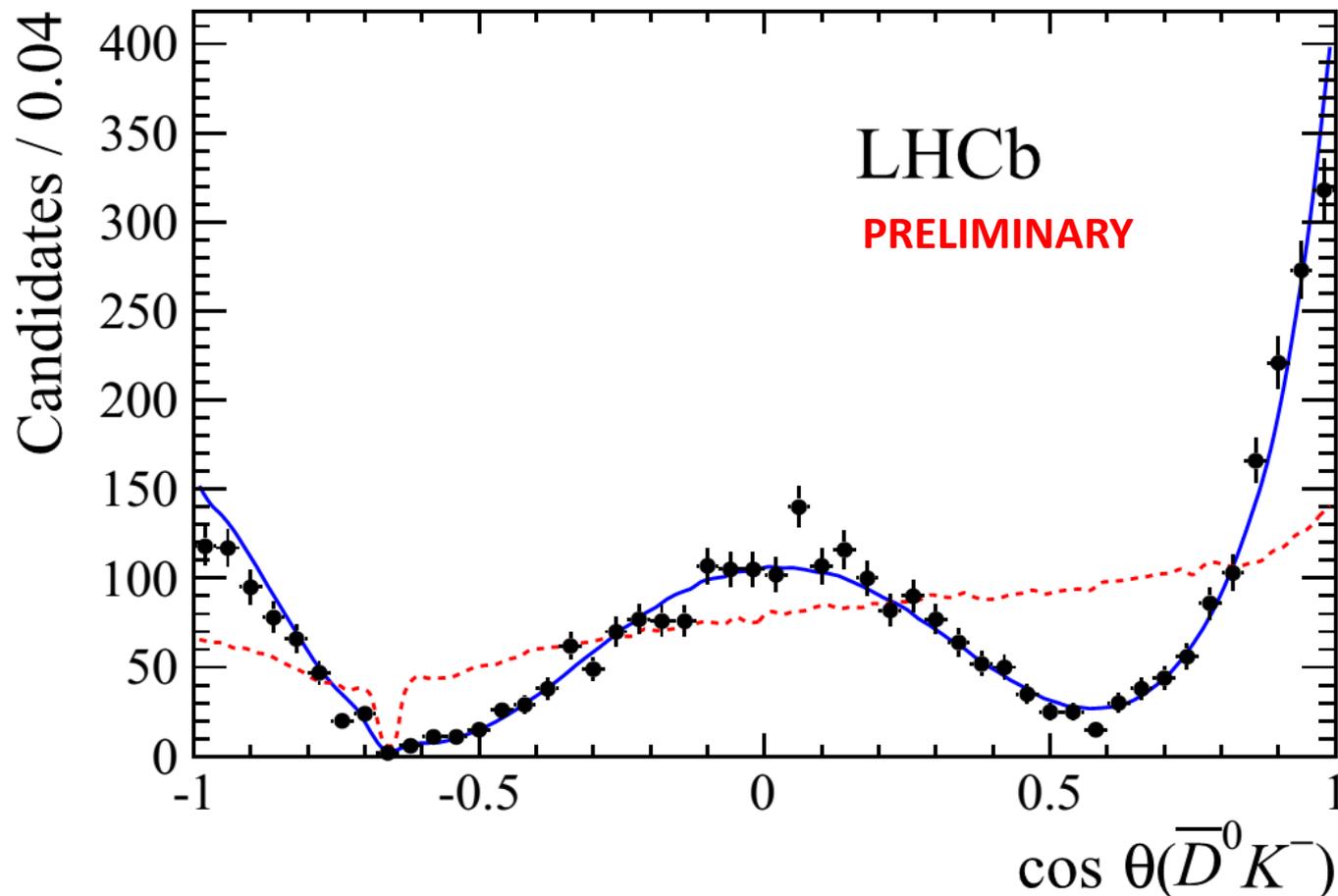| Component	Parameter	Value
LASS	m_0	$1.552 \pm 0.010 \,\mathrm{GeV}/c^2$
	Γ_0	$0.195 \pm 0.012 \,\mathrm{GeV}/c^2$
	a	4.9 ± 0.6
	r	0.0 ± 0.2
Nonresonant	α	$0.412 \pm 0.024 \,(\mathrm{GeV}/c^2)^{-2}$

PRELIMINARY

Legendre moments
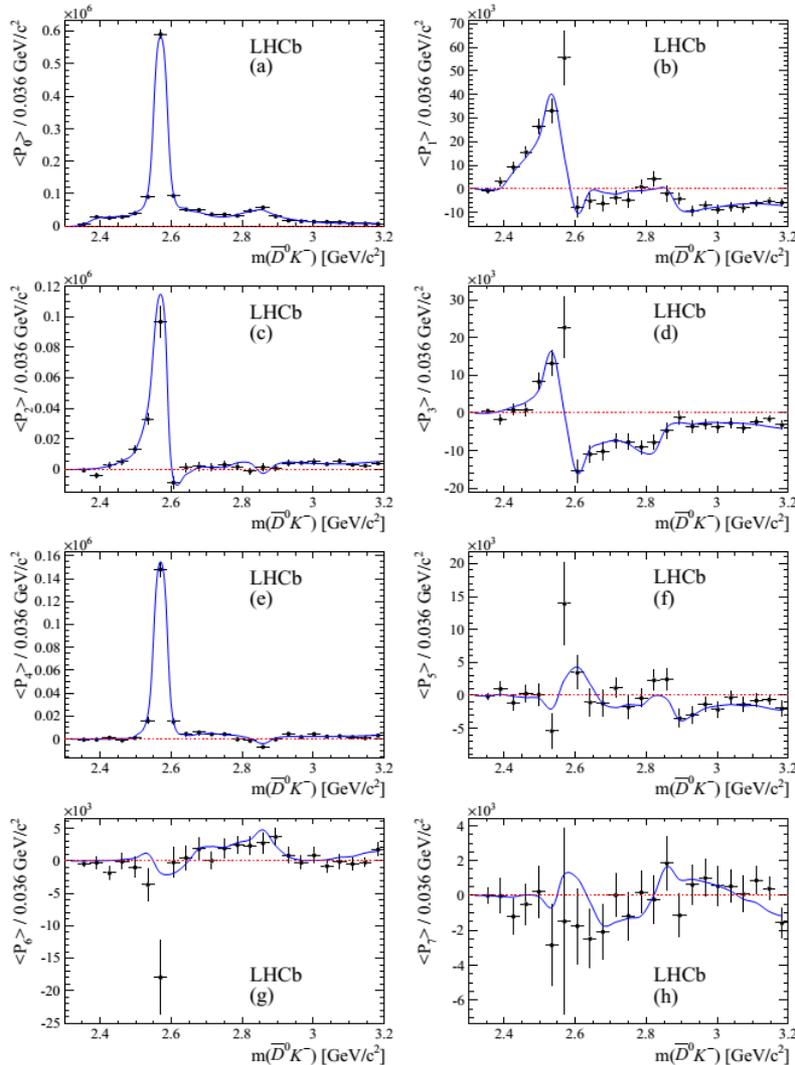
Legendre moment distributions in (left) $m(\overline{D}^0 K^-)$ and (right) $m(K^-\pi^+)$ up to P_7 for (black) data and (blue) the fit model.

PRELIMINARY

$D_{s2}^*(2573)^-$ spin

Projections of the (black) data, (blue) nominal spin-2 fit model and (red) alternative spin-0 fit model onto the cosine of the $\overline{D}^0 K^-$ helicity angle.